MODEL

IG-28 Color Bar and Dot Generator

HEATHKIT®

ASSEMBLY MANUAL

HEATHKIT®

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PRICE $2.00

595-920-09

HEATH COMPANY, BENTON HARBOR, MICHIGAN

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Sincerely,

HEATH COMPANY
Benton Harbor, Michigan 49022

Assembly
and
Operation
of the

HEATHKIT

COLOR BAR AND DOT GENERATOR

MODEL IG-28

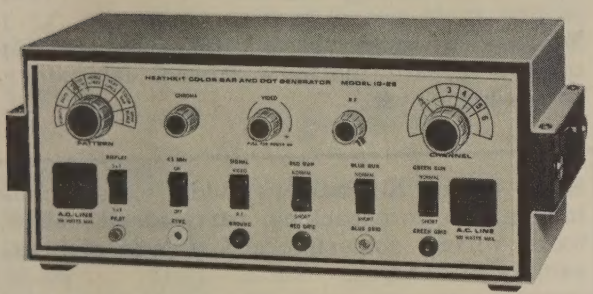


TABLE OF CONTENTS

Introduction	2
Parts List	3
Step-By-Step Assembly	4
Chassis Parts Mounting	13
Chassis Wiring	15
Alternate Line Voltage Wiring	18
Front Panel Parts Mounting	19
Rear Panel Parts Mounting	20
Front Panel Prewiring	21
Front Panel Installation And Wiring	22
Handle And Knob Installation	30
Test And Adjustment	32
Final Assembly	38
Operation	38
Principles Of Color TV	47
In Case Of Difficulty	
General Troubleshooting Information	50
Finding The Area Of Trouble	51
Troubleshooting Chart	52
Specifications	53
Theory Of Operation	55
Circuit Description	58
Chassis Photographs	65
Replacement Parts Price List	66
Schematic . . .(fold-out from Page)	69
Warranty	Inside front cover
Customer Service	Inside rear cover

HEATH COMPANY
BENTON HARBOR, MICHIGAN 49022

INTRODUCTION

The Heathkit Model IG-28 Color Bar And Dot Generator is a compact, all solid-state instrument for servicing color or black and white television receivers. It generates stable, crystal-controlled test signals to produce all the color and convergence patterns needed to accurately adjust color circuitry and tri-gun convergence systems. Twelve patterns plus purity (a clear raster for purity adjustments) can be produced. Dots, crosshatch, horizontal lines, vertical lines, color bars, and gray scale patterns are available in either a 3x3 or 9x9 display.

The patterns may also be used to service black and white receivers since the vertical and horizontal sweep circuits and the black and white portion of the video signal are basically the same in both color and black and white receivers. The color bar patterns will appear as black and white bars on a black and white receiver.

Crystal-controlled horizontal and vertical sync pulses are incorporated in the Generator. These pulses provide the necessary blanking and lock the various patterns firmly on the screen. The sync signals are also available at a front panel jack.

An RF output is available from the Generator for channels 2 through 6. The RF level control varies the RF output to check relative sensitivity and prevent overloading the RF and IF circuits of the receiver. A crystal-controlled 4.5 MHz sound carrier with an On/Off switch aids in fine tuning the generator to the receiver frequency.

The video signal is available for troubleshooting video circuits and may be adjusted with the Video Level control. The chroma signal has also been made adjustable to allow a check of color hue and sync with different signal levels. Front panel switches are provided to turn the individual red, blue, and green beam currents on or off.

All solid-state circuitry is used for long life and trouble-free operation. The integrated logic circuits used in the divider chain eliminate the need for many adjustments and greatly increase the accuracy, stability, and reliability of the instrument.

Long-life silicon diode rectifiers are used in the zener regulated power supply. The 120/240 VAC 50/60 Hz special copper-banded, low flux-leakage power transformer prevents stray magnetic fields from disrupting the receiver under test.

Enclosed in an attractive cabinet, the Generator is a versatile tool for workbench, laboratory, or "in-home" use.

Refer to the "Kit Builders Guide" for complete information on unpacking, parts identification, tools, wiring, soldering, and step-by-step assembly procedures.

PARTS LIST

The numbers in parentheses are keyed to the numbers in the Parts Pictorial (fold-out from Page 11).

To order replacement parts, refer to the Replacement Parts Price List and use the Parts Order Form furnished with this kit.

PART No.	PARTS Per Kit	DESCRIPTION
RESISTORS		
1/2 Watt		
(1) 1-111	3	150 Ω (brown-green-brown)
1-4	2	330 Ω (orange-orange-brown)
1-9	4	1000 Ω (brown-black-red)
1-90	2	2000 Ω (red-black-red)
1-122	2	3300 Ω (orange-orange-red)
1-46	4	3900 Ω (orange-white-red)
1-43	2	4700 Ω (yellow-violet-red)
1-113	1	5600 Ω (green-blue-red)
1-105	5	10 kΩ (brown-black-orange)
1-109	1	12 kΩ (brown-red-orange)
1-21	2	15 kΩ (brown-green-orange)
1-58	2	22 kΩ (red-red-orange)
1-124	1	27 kΩ (red-violet-orange)
1-76	2	33 kΩ (orange-orange-orange)
1-47	1	56 kΩ (green-blue-orange)
1-26	5	100 kΩ (brown-black-yellow)
1-30	1	270 kΩ (red-violet-yellow)
5 Watt		
(2) 3-7-5	2	11 Ω wire-wound
CAPACITORS		
Resin		
(3) 20-52	2	7.5 pF
20-99	2	22 pF
20-101	1	47 pF
20-76	1	68 pF
20-106	2	390 pF
20-113	2	470 pF
20-107	2	680 pF
20-108	1	200 pF
Disc		
(4) 21-115	1	9 pF
21-140	1	.001 μF
21-27	6	.005 μF
21-95	2	.1 μF
Other Capacitors		
(5) 25-147	1	10 μF tubular electrolytic
(6) 25-115	2	10 μF vertical electrolytic
25-148	3	1000 μF electrolytic
(7) 26-130	1	Variable capacitor
(8) 27-28	1	.1 μF Mylar*
(9) 31-36	3	Trimmer capacitor

*DuPont Registered Trademark

PART No.	PARTS Per Kit	DESCRIPTION
CONTROLS-SWITCHES		
(10) 10-270	1	200 Ω control
10-269	1	2000 Ω (2 kΩ) control
(11) 10-201	1	10 kΩ miniature control
10-393	1	5 MΩ miniature control
(12) 19-116	1	10 kΩ control with switch
(13) 60-24	4	SPST rocker switch
(14) 60-28	2	3PDT rocker switch
(15) 63-472	1	Rotary switch
CLIPS-JACKS-SOCKETS		
(16) 260-1	3	Alligator clip
260-52	3	Lead piercing alligator clip
(17) 260-31	1	Fahnestock clip
(18) 436-11	1	Red banana jack
436-22	1	Black banana jack
436-24	1	White banana jack
436-29	1	Green banana jack
436-30	1	Blue banana jack
434-148	2	AC power socket
(19) 432-144	140	IC connector
DIODES-CRYSTALS-PILOT LAMP		
(20) 56-20	6	Crystal diode 1N295 (red-white-green)
(21) 56-50	1	Zener diode
(22) 57-27	2	Silicon diode
(23) 404-3	1	3563.795 kHz (3.56 MHz) crystal
404-4	1	4500.000 kHz (4.5 MHz) crystal
404-343	1	190.08 kHz crystal
412-24	1	Pilot lamp
TRANSISTORS-INTEGRATED CIRCUITS		
NOTE: A transistor or IC (integrated circuit) may be identified by either the part number or the manufacturer's number or both.		
(24) 417-108	1	2N3692 transistor
417-801	9	MPSA20 transistor
(25) 417-116	2	S2091 (2N3638) transistor
(26) 443-21	2	MC717P IC
443-9	7	MC790P IC
443-10	1	MC723P IC

WIRE-CABLE-SLEEVING

PART No.	PARTS Per Kit	DESCRIPTION
89-16	1	2-wire lamp cord
89-23	1	3-wire line cord
134-192	1	Small wiring harness
134-193	1	Large wiring harness
340-8	1	Bare wire
343-9	1	Shielded cable
347-38	1	4-wire cable
346-4	1	Small sleeving
340-11	1	Large bare wire
346-46	1	1/4" heat shrinkable sleeving

INSULATORS

(27)	73-20	1	Red alligator clip insulator
	73-21	5	Black alligator clip insulator
(28)	75-29	1	4-wire cable strain relief
	75-30	1	*Round line cord strain relief
(29)	75-71	1	Flat line cord strain relief
(30)	75-107	1	Shielded cable strain relief

*This strain relief is supplied for areas outside the U.S., where two or three lead round line cords are required.

HARDWARE

(31)	250-156	2	4-40 x 1/8" setscrew
(32)	250-138	3	6-32 x 3/16" screw
(33)	250-56	22	6-32 x 1/4" screw
(34)	250-229	8	6-32 x 1/4" phillips head screw
(35)	250-535	4	6-32 x 1/4" decorative head screw
(36)	250-365	8	#6 x 1/4" hex head screw
(37)	250-250	15	6-32 x 1/2" black screw
(38)	250-304	4	Threaded stud
(39)	252-3	15	6-32 nut
(40)	252-7	5	Control nut
(41)	435-9	1	Push-on nut
(42)	253-10	5	Control flat washer
(43)	254-1	15	#6 lockwasher
(44)	254-4	4	Control lockwasher
(45)	259-1	4	#6 solder lug

BUSHING-KNOBS-FEET

(46)	455-38	1	Shaft bushing
(47)	455-50	5	Knob insert
	462-246	2	Large knob
	462-248	3	Small knob
	261-28	4	Foot
(48)	261-30	4	Line cord retainer

METAL PARTS

(49)	90-401-2	2	Cabinet shell
(50)	100-771	2	Cabinet side rail
(51)	100-841	1	Front panel assembly
(52)	100-842	1	Rear panel assembly
(53)	200-553	1	Chassis
(54)	204-759-1	4	End cap
(55)	204-816	1	Tuning capacitor mounting bracket
(56)	210-35	1	Bezel

TOOLS

	490-5	1	Nut starter
	490-23	1	Allen wrench
	490-71	1	Alignment tool
(57)	490-111	1	IC puller

MISCELLANEOUS

(58)	40-581	2	620 μH coil (blue-red-brown)
	54-249	1	Power transformer
	85-1176-2	1	Divider circuit board
	85-297-1	1	Video-RF circuit board
(59)	100-694	2	Dial pointer
	211-32	2	Plastic handle
(60)	432-27	1	Power plug adapter
	421-33	1	1/4 ampere slow-blow fuse
(61)	422-1	1	Fuseholder
	391-34	1	Identification label
	597-308	1	Kit Builders Guide
	597-260	1	Parts Order Form
		1	Manual (see front cover for part number)
			Solder

STEP-BY-STEP ASSEMBLY

Before you start the circuit board assembly, be sure to read the Circuit Board Parts Mounting and Soldering sections (Pages 11, 12, and 13) of the Kit Builders Guide.

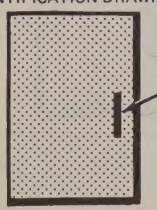
Resistors will be called out by their resistance value in Ω or kΩ, and color code. Use 1/2 watt resistors unless directed otherwise.

Capacitors will be called out by their capacitance value (in pF or μF) and type (disc, electrolytic, or resin).

Identification photographs of the assembled chassis are provided on Page 65 at the rear of the Manual. Refer to these photographs from time to time as you assemble the kit. They show the actual positions of wires and components.

Position the divider circuit board as shown in Pictorial 1. Then complete each step on the Pictorial.

IDENTIFICATION DRAWING



FOR GOOD SOLDERED CONNECTIONS, YOU MUST KEEP THE SOLDERING IRON TIP CLEAN...

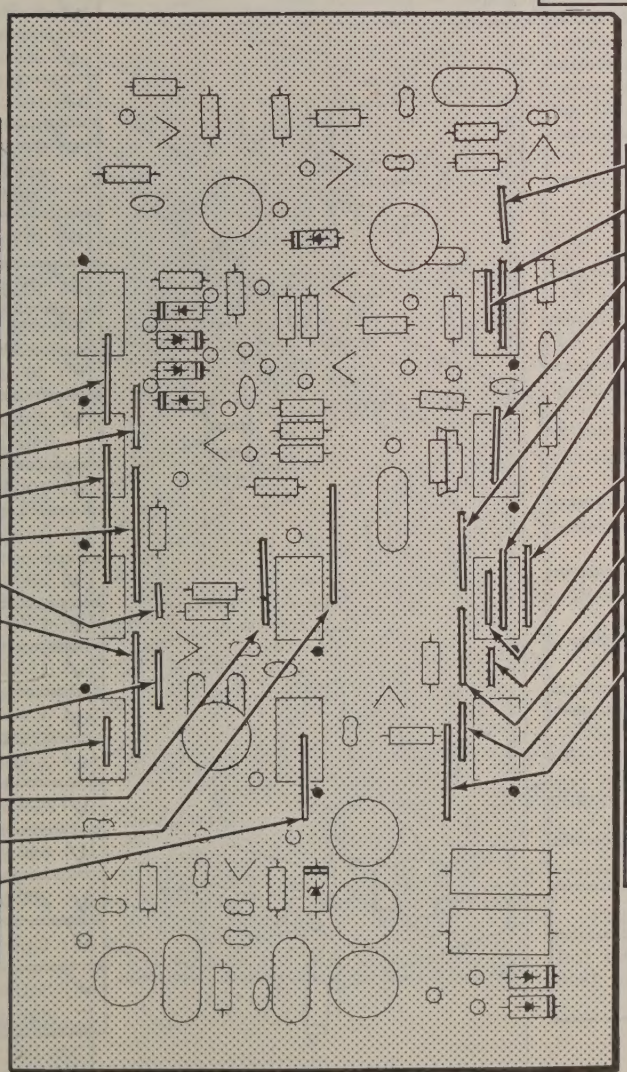
WIPE IT OFTEN WITH A DAMP SPONGE OR CLOTH.

START

Position the divider circuit board with the part number as shown in the identification drawing. Then complete each step on the Pictorial.

NOTE: In the following steps, the jumper wires will be installed on the circuit board. Use small bare hookup wire and cut it to the length specified. Be careful that you do not bridge solder between two adjacent foils on the circuit board when you make a connection.

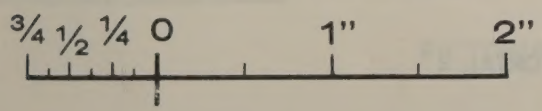
- (✓) 1-1/4" bare wire.
- (✓) 1" bare wire.
- (✓) 1-3/4" bare wire.
- (✓) 1-3/4" bare wire.
- (✓) 3/4" bare wire.
- (✓) 1-1/2" bare wire.
- (✓) Solder the wires to the foil and cut off the excess lead lengths.
- (✓) 1" bare wire.
- (✓) 7/8" bare wire.
- (✓) 1-1/4" bare wire.
- (✓) 1-1/2" bare wire.
- (✓) 1-1/4" bare wire.
- (✓) Solder the wires to the foil and cut off the excess lead lengths.



CONTINUE

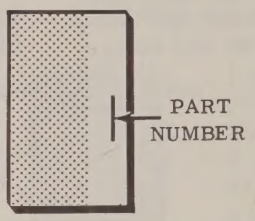
- (✓) 1" bare wire.
- (✓) 1-1/4" bare wire.
- (✓) 1" bare wire.
- (✓) 1-1/8" bare wire.
- (✓) 1-1/8" bare wire.
- (✓) 1-1/8" bare wire.
- (✓) Solder the wires to the foil and cut off the excess lead lengths.
- (✓) 1-1/8" bare wire.
- (✓) 1" bare wire.
- (✓) 3/4" bare wire.
- (✓) 1-1/4" bare wire.
- (✓) 1" bare wire.
- (✓) 1-1/4" bare wire.
- (✓) Solder the wires to the foil and cut off the excess lead lengths.
- (✓) Check to see that twenty-three jumper wires are installed and properly soldered to the foil. Be sure these wires do not touch one another on the lettered side of the circuit board.

PROCEED TO PICTORIAL 2.



PICTORIAL 1

IDENTIFICATION DRAWING



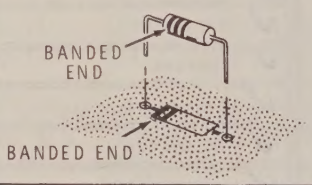
KEEP YOUR *Soldering iron tip* CLEAN

START

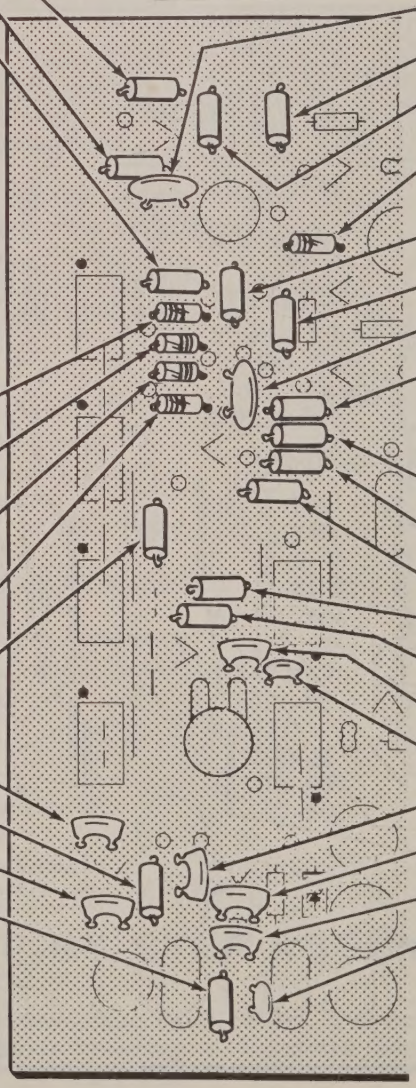
NOTE: Only part of the circuit board is shown in Pictorial 2. The identification drawing at the top of the Pictorial shows the area of the circuit board to be assembled.

- (✓) 3300 Ω (orange-orange-red).
- (✓) 330 Ω (orange-orange-brown).
- (✓) 15 kΩ (brown-green-orange).

NOTE: When you install the crystal diodes in the following steps, be sure to position the banded end as shown on the circuit board.



- (✓) Crystal diode (red-white-green).
- (✓) Crystal diode (red-white-green).
- (✓) Crystal diode (red-white-green).
- (✓) Crystal diode (red-white-green).
- (✓) 3300 Ω (orange-orange-red).
- (✓) Solder the leads to the foil and cut off the excess lead lengths.
- (✓) 390 pF resin.
- (✓) 10 kΩ (brown-black-orange).
- (✓) 680 pF resin.
- (✓) 2000 Ω (red-black-red).
- (✓) Solder the leads to the foil and cut off the excess lead lengths.

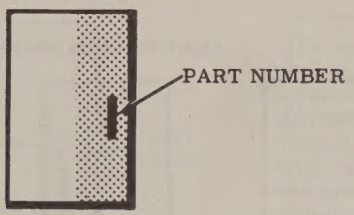


CONTINUE

- (✓) .1 μF disc capacitor.
- (✓) 3900 Ω (orange-white-red).
- (✓) 100 kΩ (brown-black-yellow).
- (✓) Crystal diode (red-white-green). Note the location of the banded end.
- (✓) 10 kΩ (brown-black-orange).
- (✓) 1000 Ω (brown-black-red).
- (✓) .005 μF disc.
- (✓) 56 kΩ (green-blue-orange).
- (✓) Solder the leads to the foil and cut off the excess lead lengths.
- (✓) 1000 Ω (brown-black-red).
- (✓) 4700 Ω (yellow-violet-red).
- (✓) 3900 Ω (orange-white-red).
- (✓) 1000 Ω (brown-black-red).
- (✓) 15 kΩ (brown-green-orange).
- (✓) 470 pF resin.
- (✓) .1 μF disc.
- (✓) 7.5 pF resin.
- (✓) 680 pF resin.
- (✓) 390 pF resin.
- (✓) 9 pF disc.
- (✓) Solder the leads to the foil and cut off the excess lead lengths.

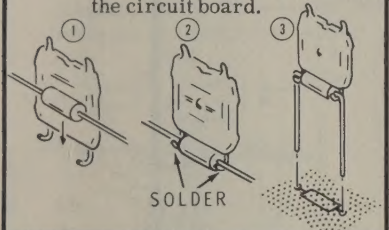
PICTORIAL 2

IDENTIFICATION DRAWING

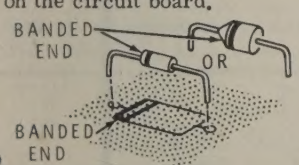


START

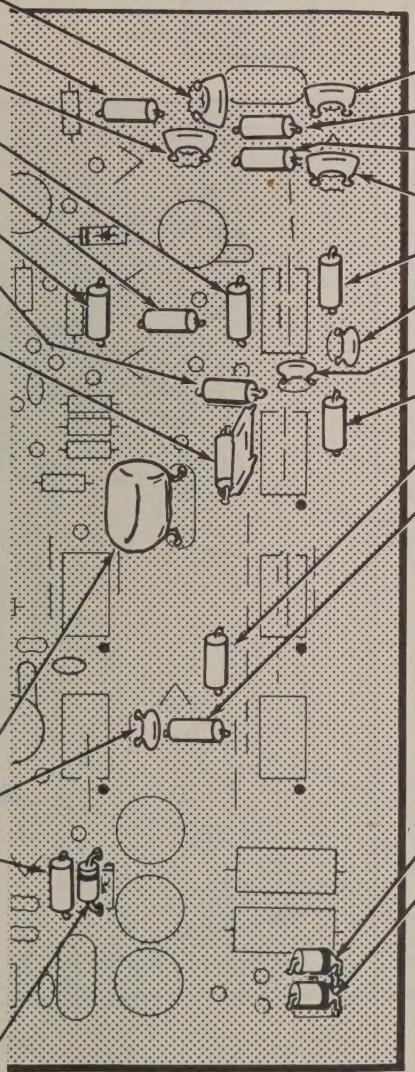
- (✓) 22 pF resin.
- (✓) 33 kΩ (orange-orange-orange).
- (✓) 47 pF resin.
- (✓) 4700 Ω (yellow-violet-red).
- (✓) 27 kΩ (red-violet-orange).
- (✓) 100 kΩ (brown-black-yellow).
- (✓) 12 kΩ (brown-red-orange).
- (✓) 2000 Ω (red-black-red) resistor and 620 μH coil. Prepare the combination as follows:
  1. Bend the leads of the coil as shown.
  2. Install the resistor in these bent leads. Solder both connections.
  3. Install this combination on the circuit board.



- (✓) .1 μF Mylar.
- (✓) .001 μF disc.
- (✓) 10 kΩ (brown-black-orange).
- (✓) Zener diode (#56-50). Be sure to position the banded end as shown on the circuit board.



- (✓) Solder the leads to the foil and cut off the excess lead lengths.



CONTINUE

- (✓) 470 pF resin.
- (✓) 270 kΩ (red-violet-yellow).
- (✓) 22 kΩ (red-red-orange).
- (✓) 22 pF resin.
- (✓) 3900 Ω (orange-white-red).
- (✓) .005 μF disc.
- (✓) .005 μF disc.
- (✓) 3900 Ω (orange-white-red).
- (✓) 150 Ω (brown-green-brown).
- (✓) 1000 Ω (brown-black-red).

NOTE: When you install the diodes in the next two steps, be sure you position the cathode end as shown. The cathode end will be marked with a color dot, color band, or color end.

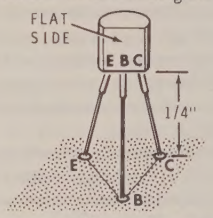
- (✓) Silicon diode (#57-27).
- (✓) Silicon diode (#57-27).
- (✓) Solder the leads to the foil and cut off the excess lead lengths.

PROCEED TO PICTORIAL 4.

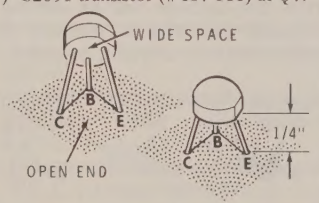
PICTORIAL 3

START

MPSA20 transistors (#417-801) will be installed in the following steps. Install the transistors as follows: Position the transistor over the outline on the circuit board. Insert the transistor leads into their correct holes which are indicated by E, B, and C, Position the transistor approximately 1/4" above the circuit board. Then solder the leads to the foil and cut off the excess lead lengths.



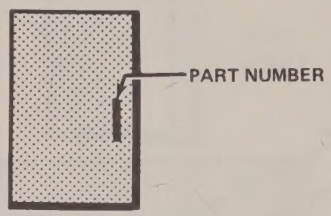
- (✓) MPSA20 transistor (#417-801) at Q3.
- (✓) MPSA20 transistor (#417-801) at Q2.
- (✓) MPSA20 transistor (#417-801) at Q1.
- (✓) MPSA20 transistor (#417-801) at Q9.
- (✓) MPSA20 transistor (#417-801) at Q8.
- (✓) S2091 transistor (#417-116) at Q7.

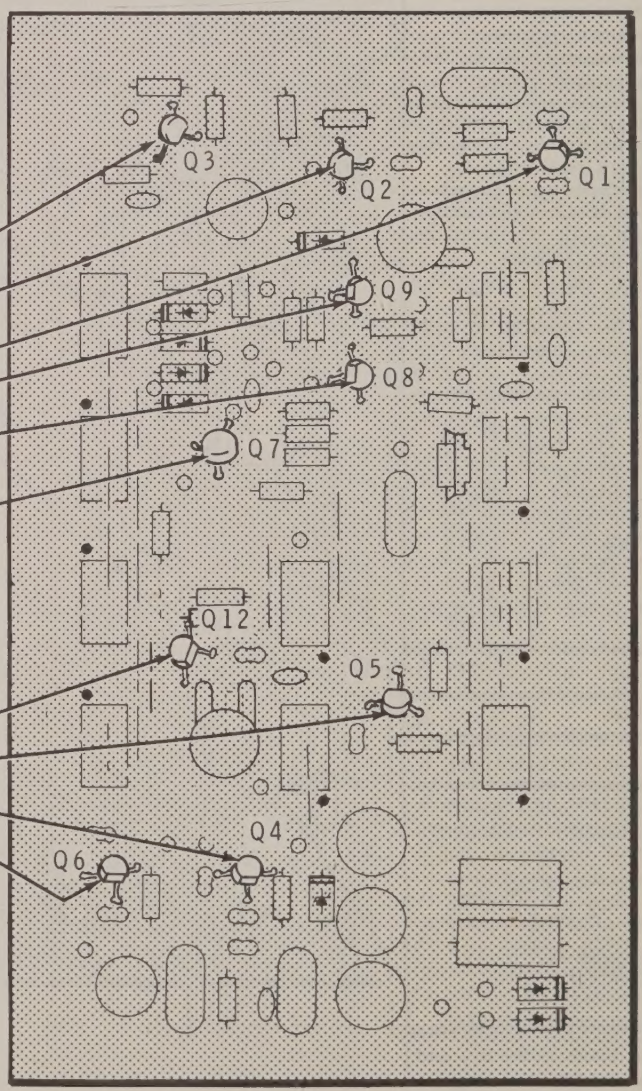


- (✓) MPSA20 transistor (#417-801) at Q12.
- (✓) MPSA20 transistor (#417-801) at Q5.
- (✓) MPSA20 transistor (#417-801) at Q4.
- (✓) MPSA20 transistor (#417-801) at Q6.

PROCEED TO PICTORIAL 5.

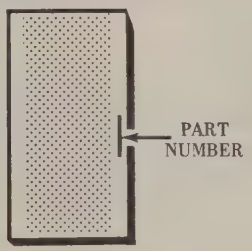
IDENTIFICATION DRAWING





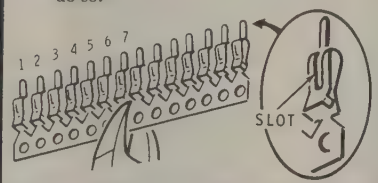
PICTORIAL 4

IDENTIFICATION DRAWING



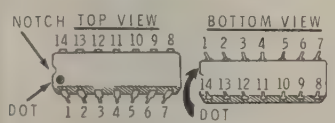
START

(✓) Cut off twenty (20) strips of seven connectors. Note the numbering of the connectors. Do not remove the individual connectors until directed to do so.

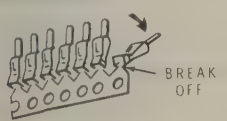


NOTES:

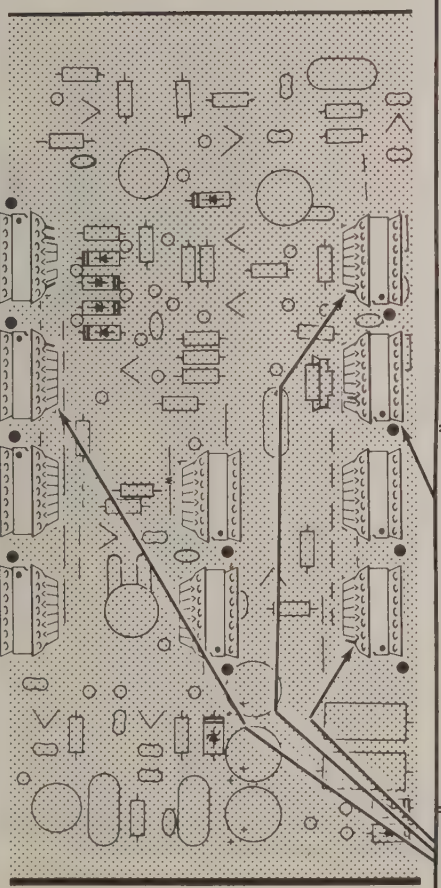
1. A dot or notch on the top of the IC designates pin 1. Refer to the pin numbering illustration below.



2. When it is necessary to remove one or more of the connectors from the strip, bend the connector back until it breaks off. Do not remove the pins from the integrated circuits.



3. Solder the connectors to the foil as each IC is installed.

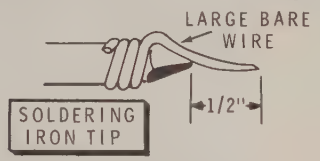


PICTORIAL 5

CONTINUE

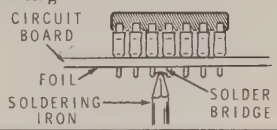
Use a small-tip soldering iron. Since the IC connectors are close together, do not place the soldering iron tip between them, as this increases the possibility of a solder bridge.

If a small-tip soldering iron is not available, turn off your soldering iron and allow it to cool. Then, wrap the large bare wire, supplied with this kit, tightly around the soldering iron tip. Allow approximately 1/2" of wire to extend beyond the end of the soldering iron.



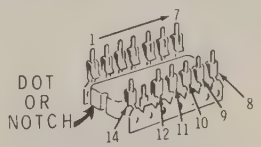
After soldering, compare the foil area with the X-Ray View (fold-out from Page 65) to be sure there are no solder bridges.

If a solder bridge occurs, turn the circuit board foil-side down and hold the soldering iron tip between the two points that are bridged. The solder will flow down the tip of the soldering iron.



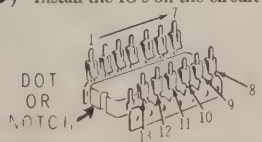
Prepare a #443-9 IC as follows:

(✓) Install a strip of connectors on pins 1 through 7.
(✓) Remove connector #6 from a strip of connectors.
(✓) Install this strip on pins 8, 9, 10, 11, 12, and 14 of the IC.
(✓) Install the IC on the circuit board.



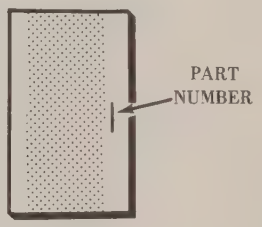
Prepare three #443-9 IC's as follows:

(✓) Install a strip of connectors on pins 1 through 7.
(✓) Remove connector #7 from a strip of connectors.
(✓) Install this strip on pins 8 through 13 of the IC.
(✓) Install the IC's on the circuit board.



PROCEED TO PICTORIAL 6.

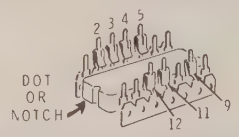
IDENTIFICATION DRAWING



START

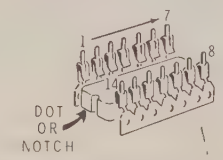
Prepare a #443-10 IC as follows:

(✓) Remove connectors #1, #6, and #7 from a strip of connectors.
(✓) Install this strip on pins 2, 3, 4, and 5 of the IC.
(✓) Remove connectors #1, #3, #6, and #7 from a strip of connectors.
(✓) Install this strip on pins 9, 11, and 12 of the IC.
(✓) Install the IC on the circuit board.



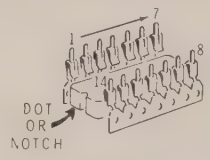
Prepare three #443-9 IC's as follows:

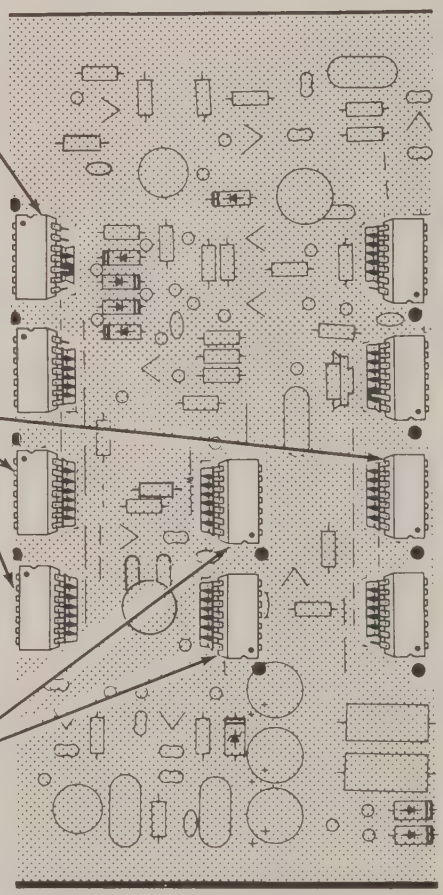
(✓) Install a strip of connectors on pins 1 through 7.
(✓) Install a strip of connectors on pins 8 through 14.
(✓) Install the IC's on the circuit board.



Prepare two #443-21 IC's as follows:

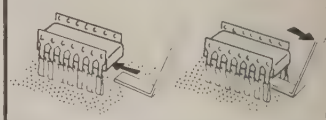
(✓) Install a strip of connectors on pins 1 through 7.
(✓) Install a strip of connectors on pins 8 through 14.
(✓) Install the IC's on the circuit board.



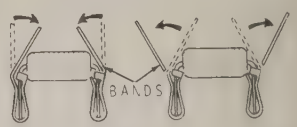


CONTINUE

NOTE: An IC puller has been included with this kit so you do not bend the pins when you remove an IC from its connectors. To use the puller, insert its foot beneath the IC; then gently rock the tool back and forth to lift the IC.



( ) Remove the bands that join the connectors. Do this by first bending the band toward the integrated circuit; then bend it outward as shown.



PROCEED TO PICTORIAL 7.

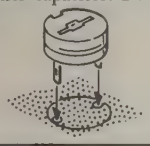
PICTORIAL 6

START

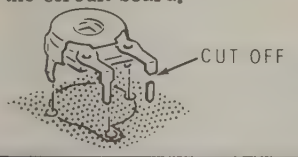
NOTE: Solder the leads of each part to the foil as it is installed, and cut off the excess lead lengths of only the resistors and electrolytic capacitors.

(✓) 190.08 kHz crystal.

( ) Trimmer capacitor. Do not cut off the lugs.



(✓) Cut the indicated lug off the 10 kΩ control (#10-201) as shown. Then install the control on the circuit board.



(✓) 5 MΩ control (#10-393). Do not cut off the lugs.

NOTE: When you install the following electrolytic capacitors, be sure you match the positive (+) marking on the capacitor with the positive (+) marking on the circuit board.

(✓) 1000 µF electrolytic.

(✓) 1000 µF electrolytic.

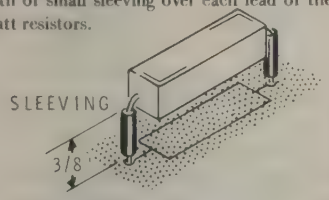
(✓) 1000 µF electrolytic.

(✓) 4500.000 kHz (4.5 MHz) crystal.

(✓) 3563.795 kHz (3.56 MHz) crystal.

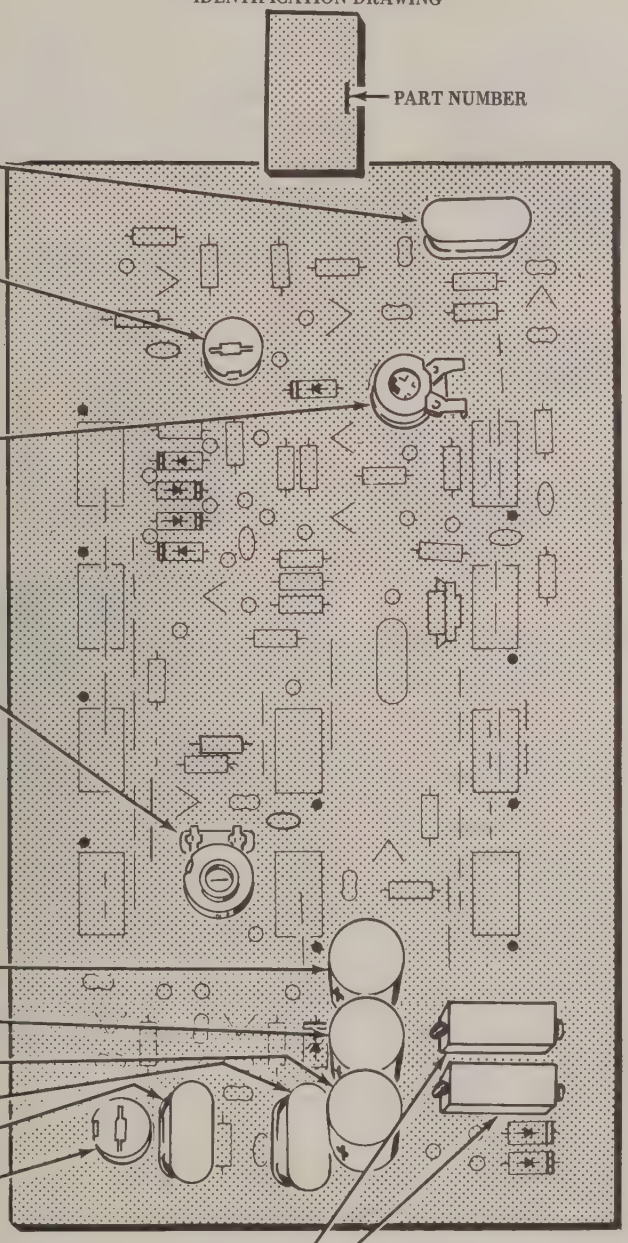
(✓) 8-50 pF trimmer.

NOTE: In the next two steps, place a 3/8" length of small sleeving over each lead of the 5 watt resistors.



FINISH

IDENTIFICATION DRAWING



PICTORIAL 7

CONTINUE

(✓) 11 Ω 5 watt resistor.

(✓) 11 Ω 5 watt resistor.

Set the circuit board aside temporarily. Proceed to Pictorial 8.

PARTS PICTO

1
2
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OR
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15
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17
18
19
ONE
CONNECTOR
20
21
22
23
24
OR
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FLAT
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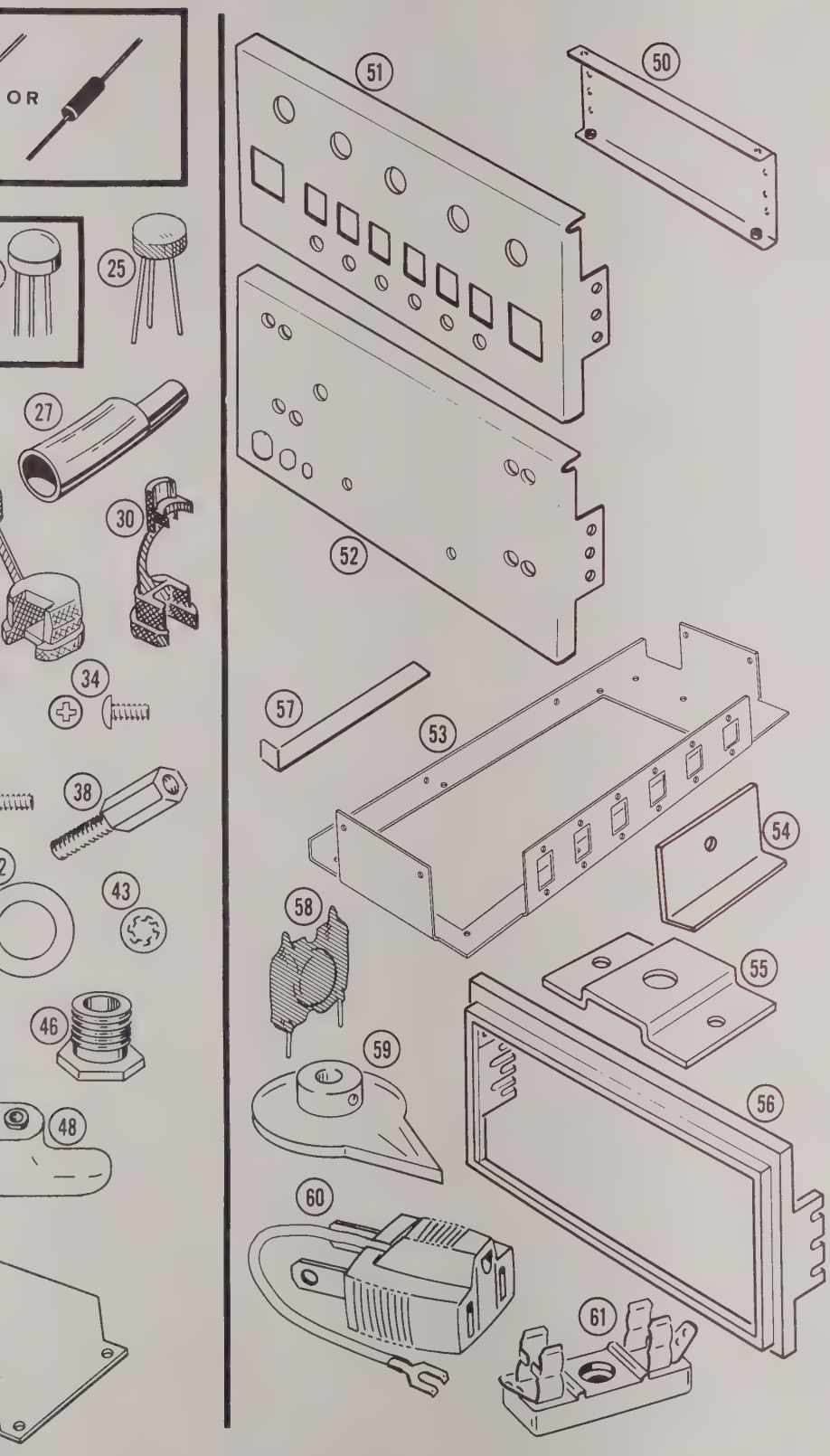
49

ORIAL



START

Position the Video-RF circuit board as shown in Pictorial 8 and complete the following steps.

(✓) Crystal diode (red-white-green). Be sure to position the banded end as shown.

(✓) 7.5 pF resin.

(✓) 10 kΩ (brown-black-orange).

(✓) 10 μF electrolytic. Position the positive (+) marking on the capacitor as shown.

(✓) 22 kΩ (red-red-orange).

(✓) Solder the leads to the foil and cut off the excess lead lengths.

(✓) 150 Ω (brown-green-brown).

(✓) .005 μF disc.

(✓) 33 kΩ (orange-orange-orange).

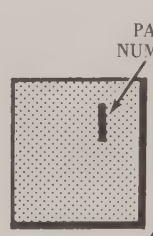
(✓) 150 Ω (brown-green-brown).

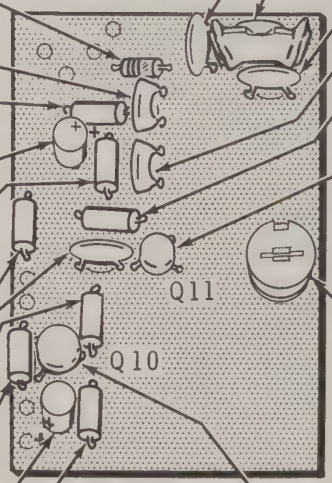
(✓) 10 μF electrolytic. Position the positive (+) marking on the capacitor as shown.

(✓) 10 kΩ (brown-black-orange).

(✓) Solder the leads to the foil and cut off the excess lead lengths.

IDENTIFICATION DRAWING





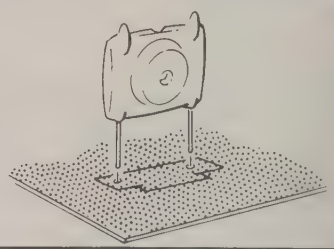
PICTORIAL 8

CONTINUE

NOTE: Solder the leads of each part to the foil as it is installed, and cut off the excess lead lengths unless otherwise indicated.

(✓) .005 μF disc.

(✓) 620 μH coil (blue-red-brown).

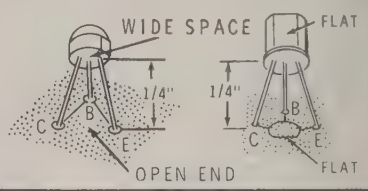


(✓) .005 μF disc.

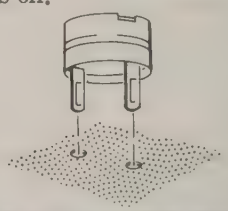
( ) 68 pF resin.

( ) 330 Ω (orange-orange-brown).

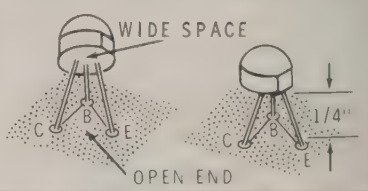
( ) 2N3692 transistor (#417-108).



( ) Trimmer capacitor. Solder the lugs to the foil. Do not cut the lugs off.

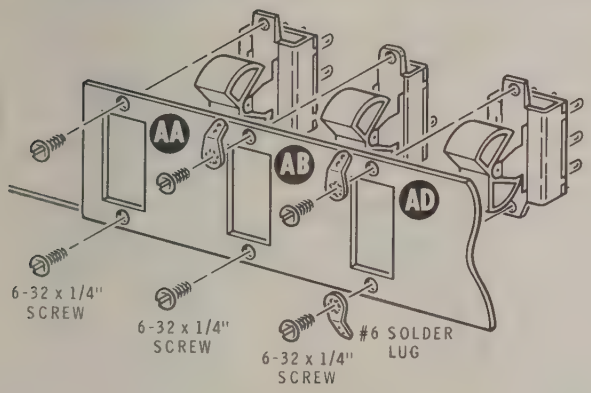


( ) S2091 transistor (#417-116).



( ) Check to be sure all leads are soldered to the foil.

Set the circuit board aside temporarily. Proceed to Page 13.



Detail 9A

CHASSIS PARTS MOUNTING

Refer to Pictorial 9 and Detail 9A for the following steps.

(✓) Position the chassis as shown.

NOTE: In the following steps, install the switches so the lugs are positioned as shown in the Pictorial.

(✓) Mount a 3PDT switch at AA with 6-32 x 1/4" screws.

(✓) Refer to Pictorial 9 and cut off lug 2 of switch AA.

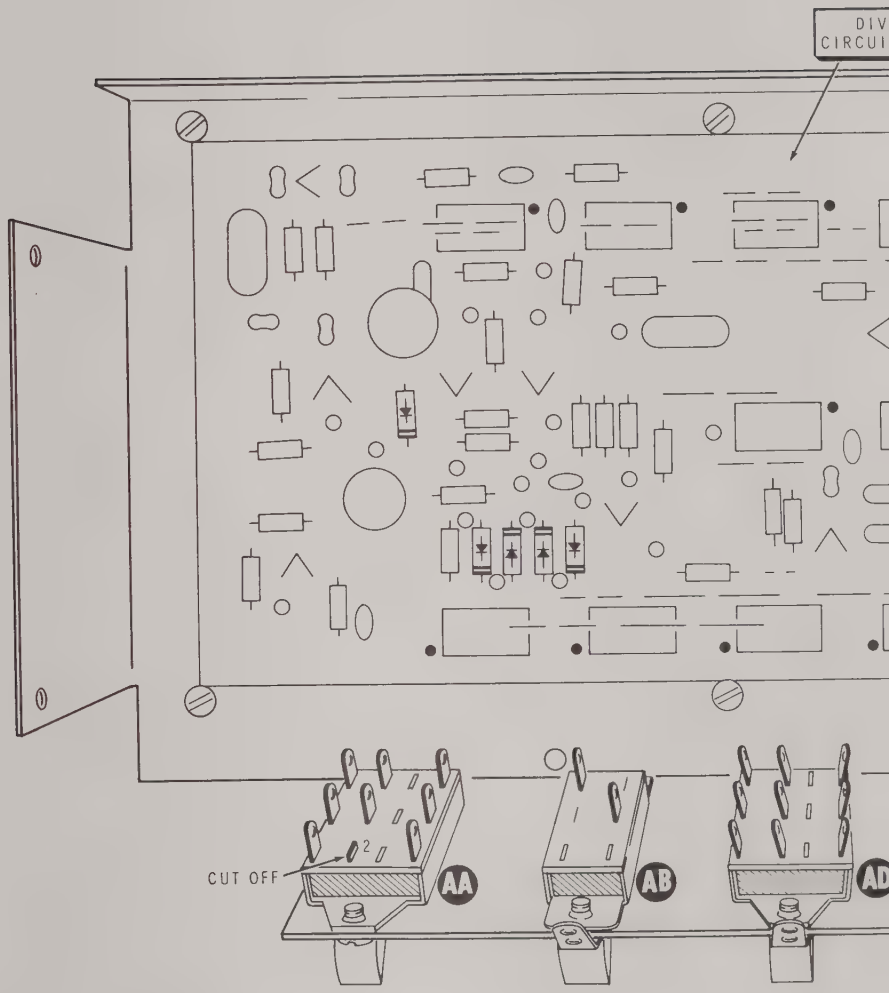
(✓) Mount a SPST switch at AB with 6-32 x 1/4" screws and a #6 solder lug.

(✓) Mount the other 3PDT switch at AD with 6-32 x 1/4" screws and two #6 solder lugs.

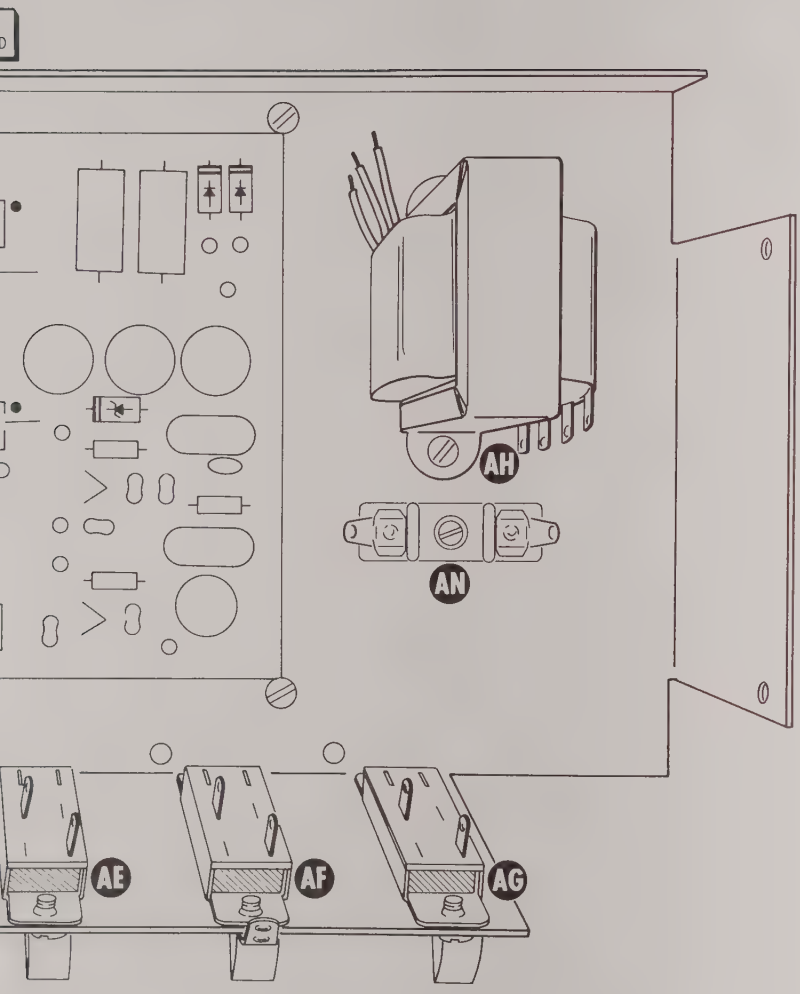
(✓) Mount a SPST switch at AE with 6-32 x 1/4" screws.

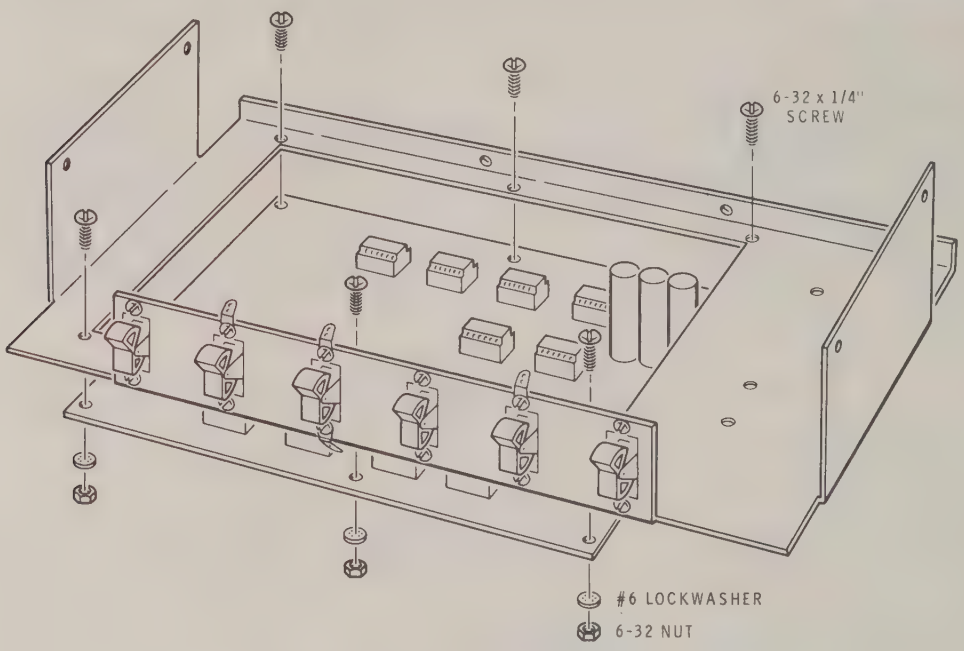
(✓) Mount a SPST switch at AF with 6-32 x 1/4" screws, and a #6 solder lug.

(✓) Mount a SPST switch at AG with 6-32 x 1/4" screws.



PICTORIA


AH
AN
AE
AF
AG

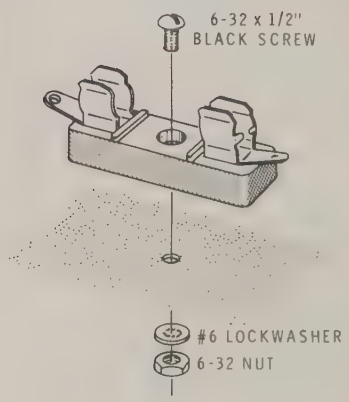


Detail 9B

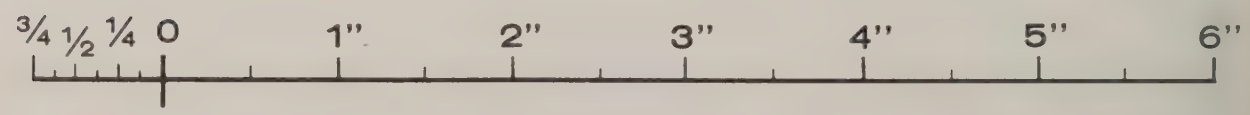
NOTE: A plastic nut starter has been provided with this kit. Use this nut starter to hold and start 6-32 nuts on screws. Refer to Page 3 of the Kit Builders Guide for further information.

(✓) Refer to Detail 9B and mount the divider circuit board, exactly as shown on the bottom of the chassis with 6-32 x 1/4" screws, #6 lockwashers, and 6-32 nuts.

(✓) Refer to Detail 9C and mount the fuse block at AN with a 6-32 x 1/2" black screw, a #6 lockwasher and a 6-32 nut.

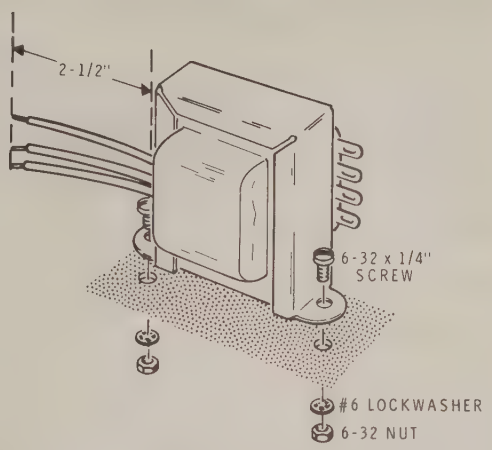


Detail 9C



( ) Refer to Detail 9D and cut the power transformer leads to 2-1/2" in length. Measure the leads from where they come out of the transformer. Then remove 1/4" of insulation from the end of each lead.

( ) Mount the power transformer at AH with 6-32 x 1/4" screws, #6 lockwashers, and 6-32 nuts as shown in Detail 9D.



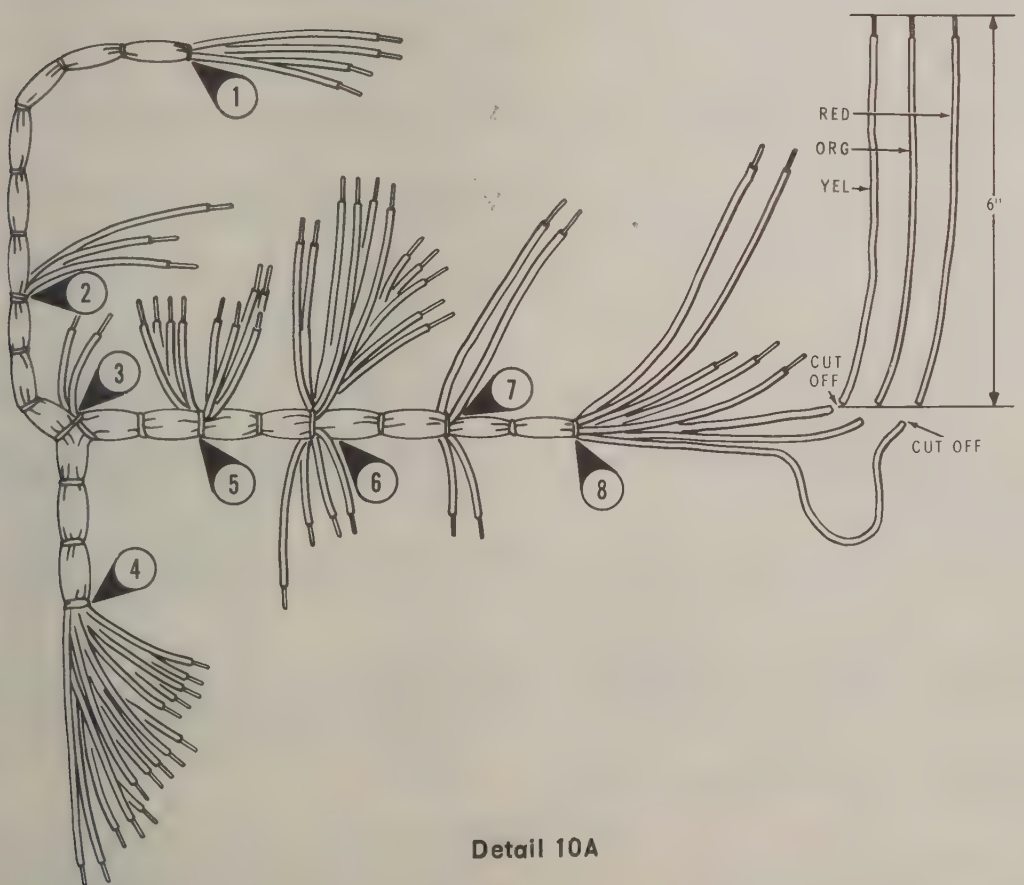
Detail 9D

CHASSIS WIRING

Refer to Detail 10A for the following steps.

( ) Position the large wiring harness #134-193 as shown. Remove 6" of wire from the orange, red, and yellow wires at BO #8 (break out #8). Save these cut-off wires, they will be used later.

( ) Remove 1/4" of insulation from the ends of the orange, red, and yellow wires of BO#8.



Detail 10A

Refer to Pictorial 10 (fold-out from Page 19) for the following steps.

(✓) Place the wiring harness in the chassis as shown.

Connect the wires from BO#1 to the circuit board as follows:

(✓) Orange to ORG (S-1).

(✓) Black to BLK (S-1).

(✓) White to WHT (S-1).

(✓) Yellow to YEL (S-1).

Connect the wires from BO#2 to the circuit board as follows:

(✓) Gray to GRY (S-1).

(✓) White to WHT (S-1).

(✓) Red to RED (S-1).

(✓) Connect the blue wire from BO #3 to BLU on the circuit board (S-1).

Connect the wires from BO #6 to the circuit board as follows:

(✓) Blue to BLU (S-1).

(✓) White-orange to WHT/ORG (S-1).

(✓) Brown to BRN (S-1).

(✓) White-red to WHT/RED (S-1).

(✓) Yellow to YEL (S-1).

The remaining wires from BO #6 will be connected later.

(✓) Pass the white wire from BO #6 through hole AC in the chassis.

Connect the wires from BO #8 to the circuit board as follows:

(✓) Orange to ORG (S-1).

(✓) White-blue to WHT/BLU (S-1).

(✓) Yellow to YEL (S-1).

(✓) White-orange to WHT/ORG (S-1).

(✓) Violet to VIOL (S-1).

(✓) Brown to lug 1 of fuse block AN (S-1).

Connect the wires from BO #5 to switch AA as follows:

(✓) Yellow to lug 7 (S-1).

(✓) White-yellow to lug 8 (S-1).

(✓) Orange to lug 9 (S-1).

(✓) White to lug 4 (S-1).

The remaining wires from BO #5 will be connected later.

(✓) Connect the violet wire from BO #6 to lug 2 of switch AB (S-1).

(✓) Connect the white-blue wire from BO #6 to lug 1 of switch AB (S-1).

(✓) Connect the white-red wire from BO #7 to lug 4 of switch AD (S-1).

(✓) Connect the green wire from BO #7 to lug 5 of switch AD (S-1).

(✓) Connect one of the red transformer leads to either circuit board hole marked RED (S-1).

(✓) Connect the other red transformer lead to the other circuit board hole marked RED (S-1).

(✓) Connect the red-yellow transformer lead to the circuit board hole marked RED/YEL (S-1).

(✓) Connect one lead of a 100 kΩ (brown-black-yellow) resistor to lug 2 of switch AE (S-1). Pass the other lead through hole AJ. Bend the lead as shown so it does not touch the switch.

(✓) In the same manner, connect one lead of a 100 kΩ (brown-black-yellow) resistor to lug 2 of switch AF (S-1). Pass the other lead through hole AK.

(✓) In the same manner, connect one lead of a 100 kΩ (brown-black-yellow) resistor to lug 2 of switch AG (S-1). Pass the other lead through hole AL.

Refer to Detail 10B for the following steps.

Connect the wires from BO#5 to switch AA as follows:

(✓) All three white-orange to lug 5 (S-3).

(✓) White-gray to lug 6 (S-1).

(✓) Remove an additional 3/8" of insulation from the end of the gray wire from BO#5.

NOTE: Where a wire passes through a connection and then goes to another point, as in the next step, it will count as two wires in the solder instructions (S-2), one entering and one leaving the connection.

(✓) Pass the gray wire from BO#5 through lug 1 (S-2) to lug 3 (S-1) of switch AA. Cut off any excess wire length.

Connect the wires from BO#6 to the circuit board as follows:

(✓) White-brown to WHT/BRN (S-1).

(✓) Gray to GRY (S-1).

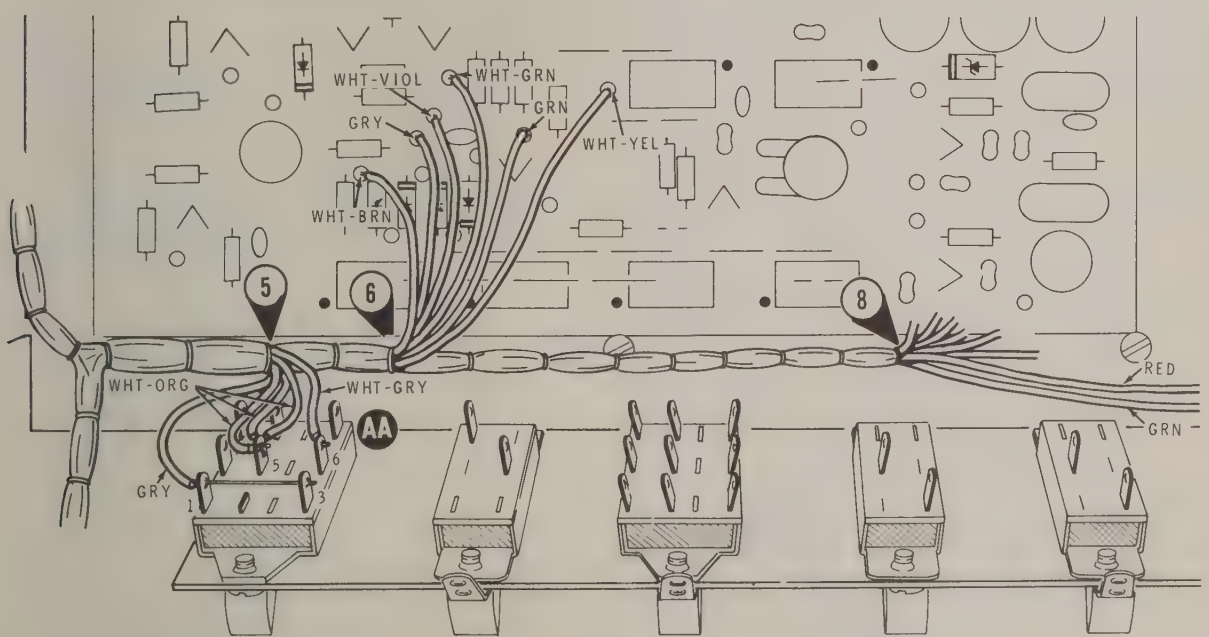
(✓) White-violet to WHT/VIOL (S-1).

(✓) White-green to WHT/GRN (S-1).

(✓) Green to GRN (S-1).

(✓) White-yellow to WHT/YEL (S-1).

The orange wire will be connected later.



Detail 10B

ALTERNATE LINE VOLTAGE WIRING

Two sets of line voltage wiring instructions are given below, one for 120 VAC line voltage and the other for 240 VAC line voltage. In the U.S.A., 120 VAC is most often used, while in foreign countries 240 VAC is more common. USE ONLY THE INSTRUCTIONS THAT AGREE WITH THE LINE VOLTAGE IN YOUR AREA.

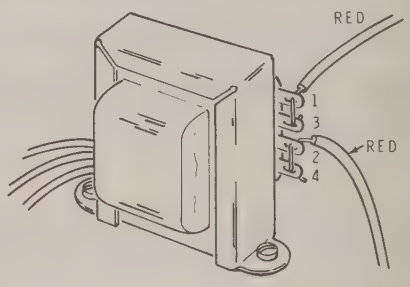
120 VAC WIRING

Refer to Detail 10C for the following steps.

(✓) Remove an additional 1/4" of insulation from the end of the red wire from BO#8. Pass the end of this wire through lug 1 (S-2) to lug 3 (NS) of power transformer AH.

(✓) Locate the red wire that was cut off of the wiring harness. Remove 1/2" of insulation from the insulated end of this wire.

(✓) Pass this wire through lug 2 (S-2) to lug 4 (NS) of power transformer AH. The other end of this wire will be connected later.



120 VAC WIRING

Detail 10C

240 VAC WIRING

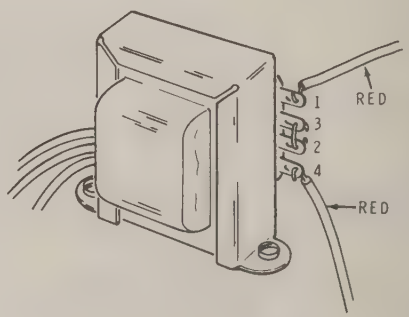
Refer to Detail 10D for the following steps.

( ) Connect the red wire from BO#8 to lug 1 of power transformer AH (NS).

( ) Locate the red wire that was cut off of the wiring harness. Remove 1/4" of insulation from the insulated end of this wire.

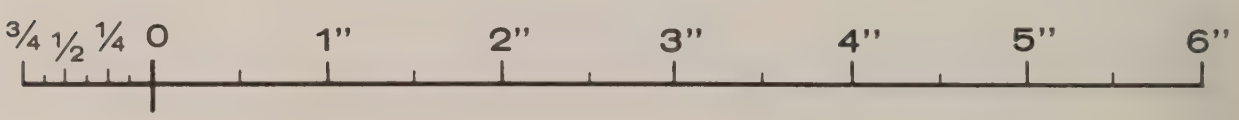
( ) Connect this wire to lug 4 of power transformer AH (NS). The other end of this wire will be connected later.

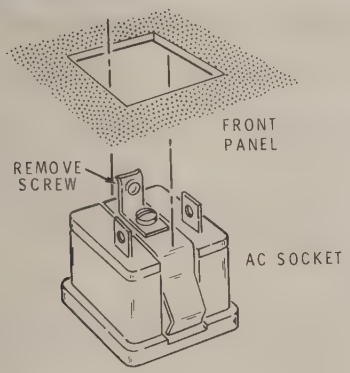
( ) Connect a 1" bare wire from lug 2 (S-1) to lug 3 (NS) of power transformer AH. Cut off the excess wire length.



240 VAC WIRING

Detail 10D





Detail 11A

FRONT PANEL PARTS MOUNTING

Refer to Pictorial 11 for the following steps.

(✓) Locate the front panel and position it as shown.

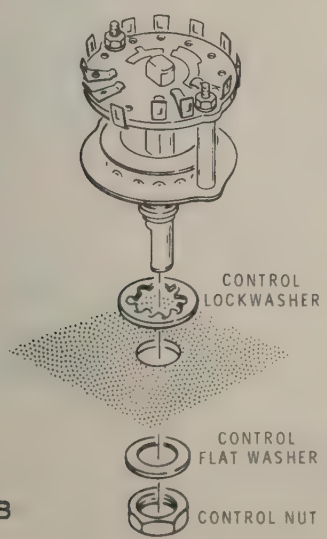
NOTE: Remove the screw (if any) on the solder lug of the two AC sockets. Discard the two screws. They will not be used.

(✓) Mount an AC socket at BA as shown in Detail 11A.

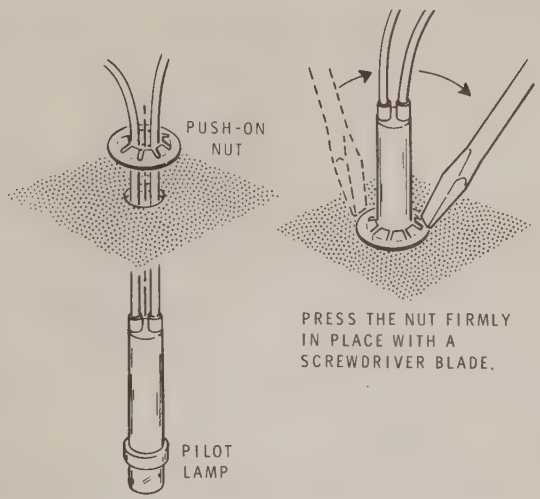
(✓) In the same manner, mount an AC socket at BG.

(✓) Mount the rotary switch (#63-472) at BB with a control lockwasher, a control flat washer, and a control nut as shown in Detail 11B. Position the switch as shown.

(✓) In the same manner, mount the 2000 Ω (2 kΩ) control (#10-269) at BC. Use a control lockwasher, a control flat washer, and a control nut.



Detail 11B



Detail 11C

(✓) Mount the control with switch (#19-116) at BD with a control lockwasher, control flat washer, and control nut.

(✓) Mount the 200 Ω control (#10-270) at BE with a control lockwasher, a control flat washer, and a control nut.

(✓) Refer to Detail 11C and mount the pilot lamp at BH with a push-on nut.

(✓) Refer to Detail 11D and mount the white banana jack at BJ with the nut provided on the banana jack.

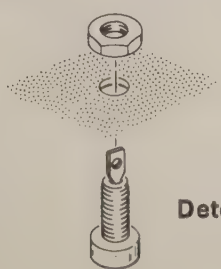
(✓) In the same manner, mount the black banana jack at BK.

(✓) Mount the red banana jack at BL.

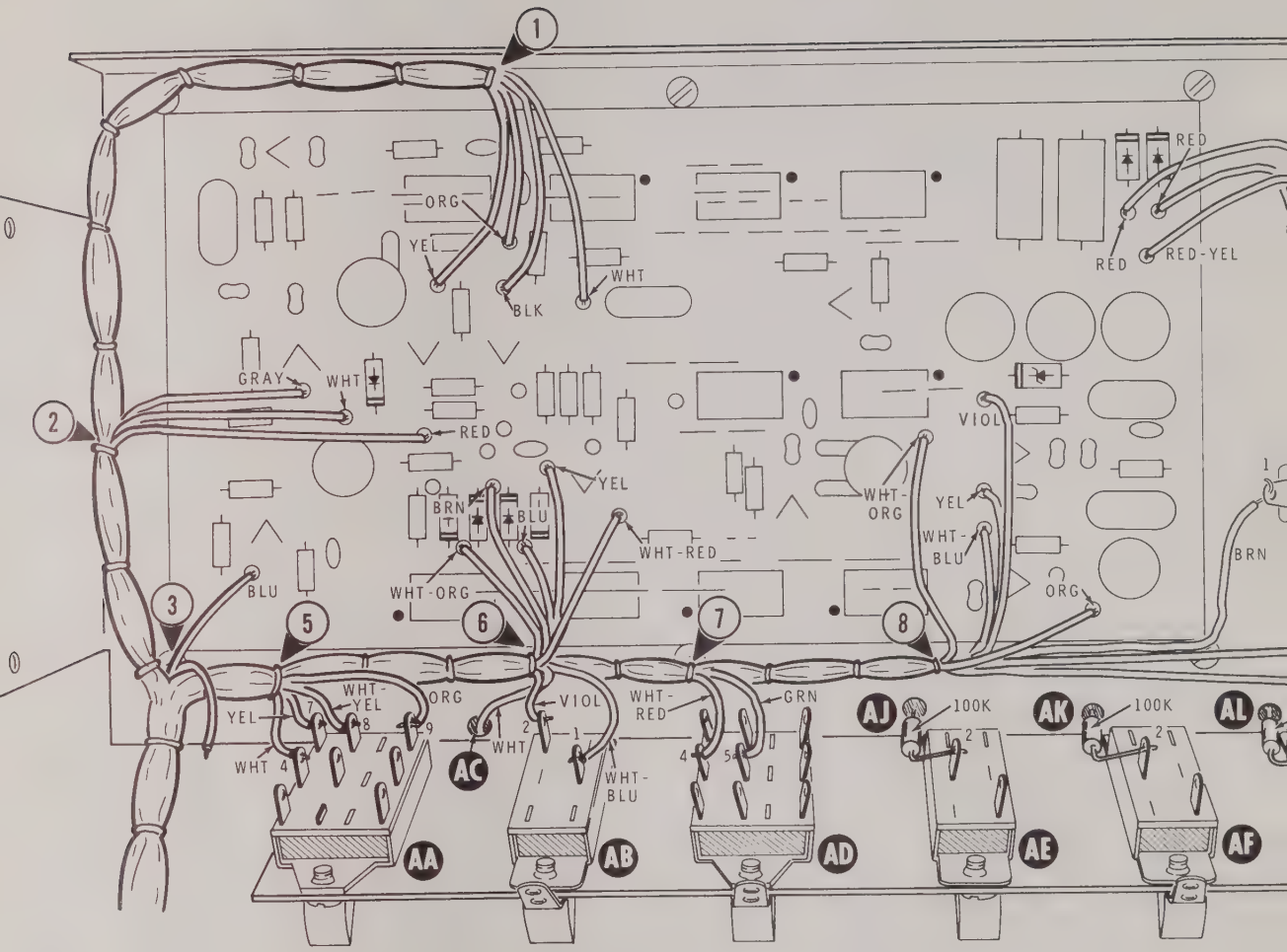
(✓) Mount the blue banana jack at BN.

(✓) Mount the green banana jack at BP.

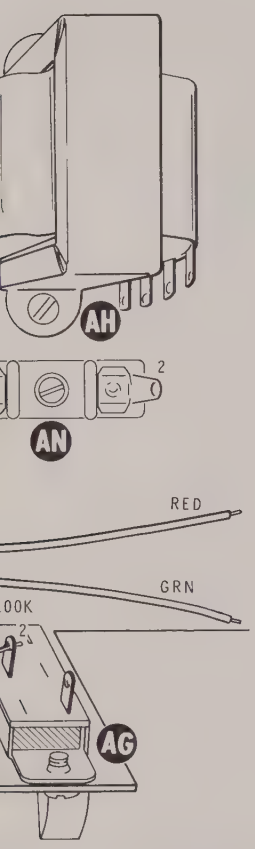
Set the front panel aside temporarily.

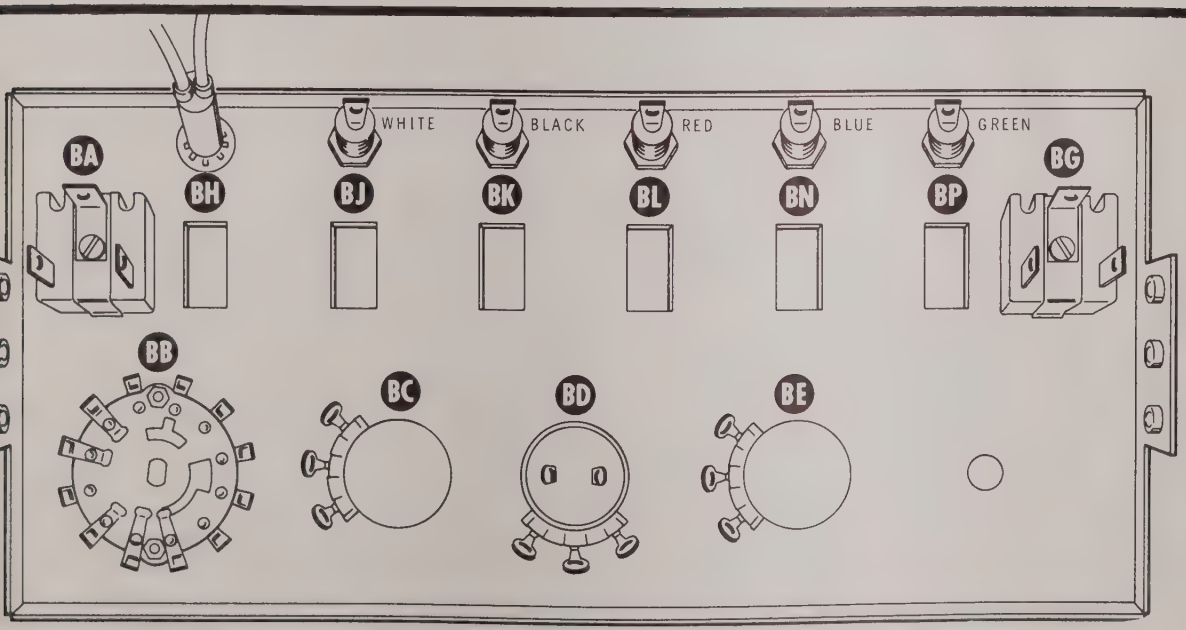


Detail 11D

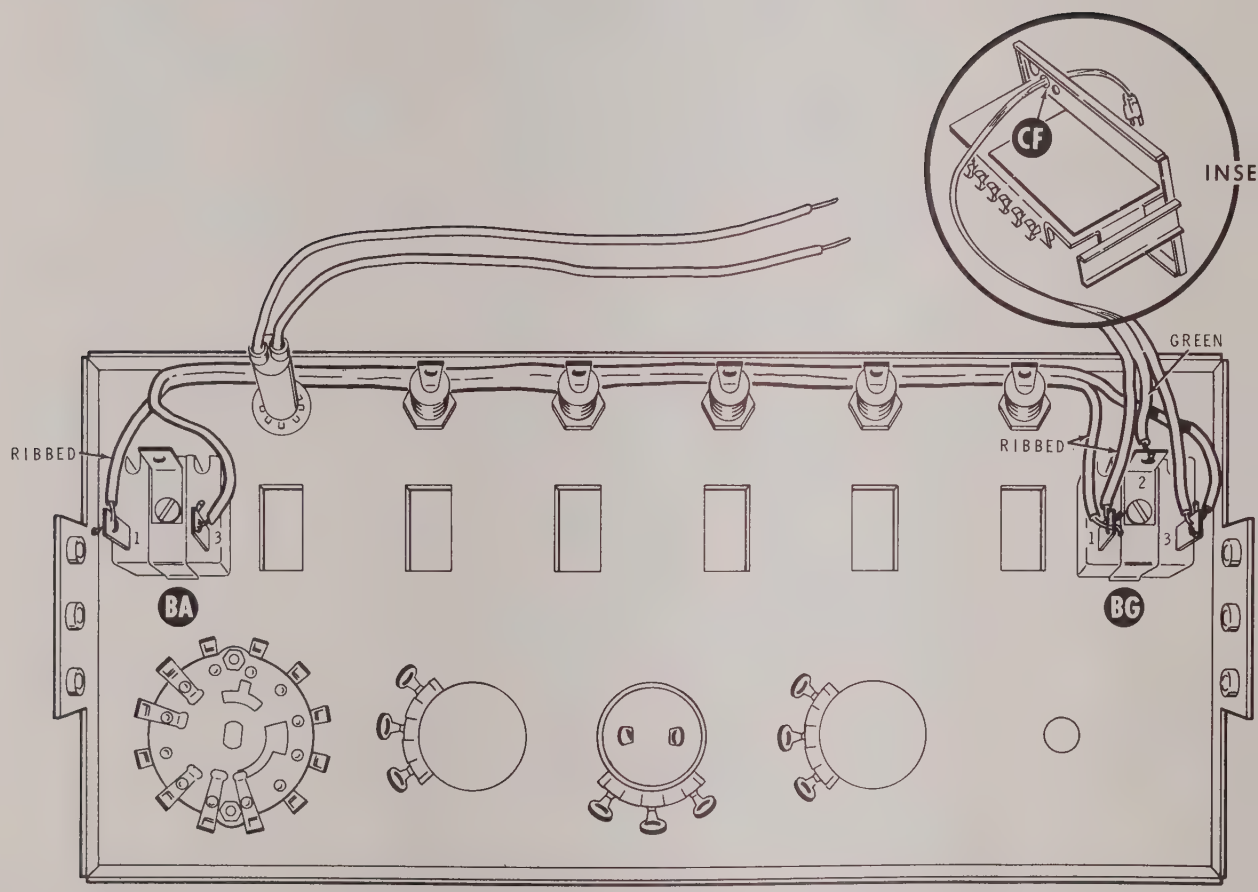


PICTORIAL 10

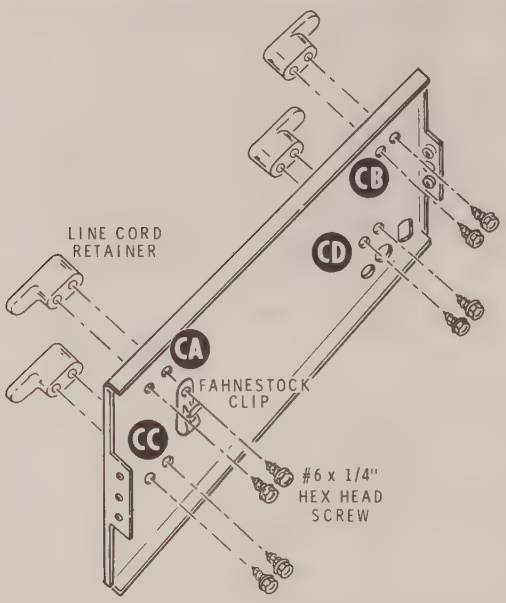




PICTORIAL 11



PICTORIAL 14



PICTORIAL 12

REAR PANEL PARTS MOUNTING

Refer to Pictorial 12 for the following steps.

(✓) Locate the rear panel and position it as shown.

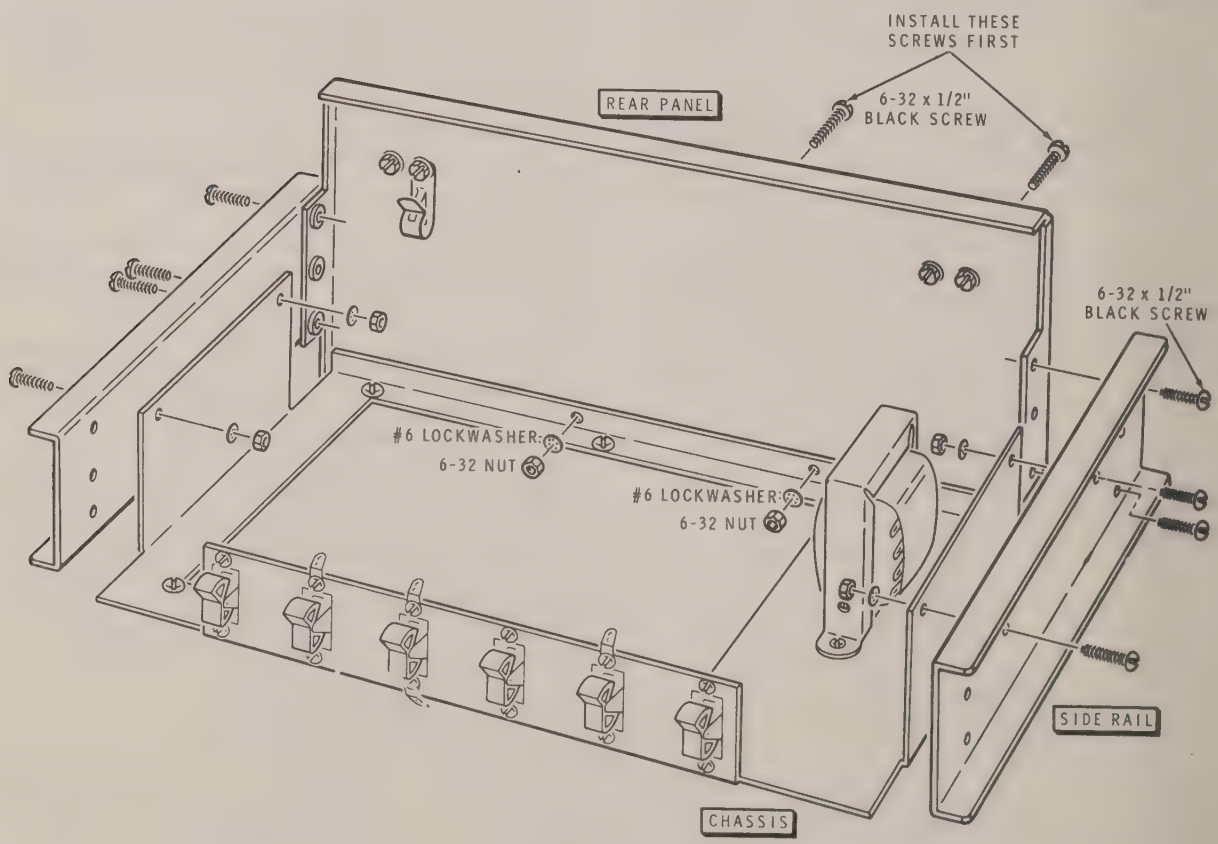
(✓) Mount a line cord retainer and fahnestock clip at CA. Use two #6 x 1/4" hex head screws.

(✓) Mount the remaining three line cord retainers at CB, CC, and CD. Use #6 x 1/4" hex head screws.

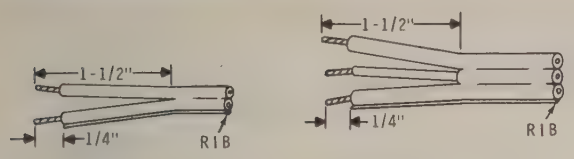
Refer to Pictorial 13 for the following steps.

(✓) Mount the side rails to the back panel as shown with four 6-32 x 1/2" black screws.

(✓) Mount the chassis to the side rails and back panel with six 6-32 x 1/2" black screws, six #6 lockwashers, and six 6-32 nuts. NOTE: Install the rear panel screws first.



PICTORIAL 13



Detail 14A

FRONT PANEL PREWIRING

Refer to Pictorial 14 for the following steps.

(✓) Refer to Detail 14A and separate the two wires of the 2-wire lamp cord for a length of 1-1/2". Then remove 1/4" of insulation from the end of each wire. Prepare the other end of the 2-wire lamp cord in the same manner.

NOTE: When connecting the 2-wire lamp cord in the following steps, it is very important that you connect the ribbed wire of the lamp cord as indicated. On some lamp cords this rib is very small and may be hard to identify.

(✓) Connect the ribbed wire at one end of the 2-wire lamp cord to lug 1 of AC socket BA (S-1).

(✓) Connect the other wire at this end of the 2-wire lamp cord to lug 3 of AC socket BA (S-1).

(✓) Connect the ribbed wire at the free end of the 2-wire lamp cord to lug 1 of AC socket BG (NS).

(✓) Connect the other wire at the free end of the 2-wire lamp cord to lug 3 of AC socket BG (NS).

NOTE: A flat 3-lead line cord is supplied with this kit that is approved for use in the U.S.A. and in some other countries. If this cord is not approved for your locality, obtain locally an approved cord and proceed with the following steps, making changes where necessary.

The flat 3-lead line cord supplied with this kit has one of its outer leads marked with a rib in the insulation along its edge. The other lead is smooth, and the third lead is color coded green. It is very important that you connect the ribbed wire as indicated.

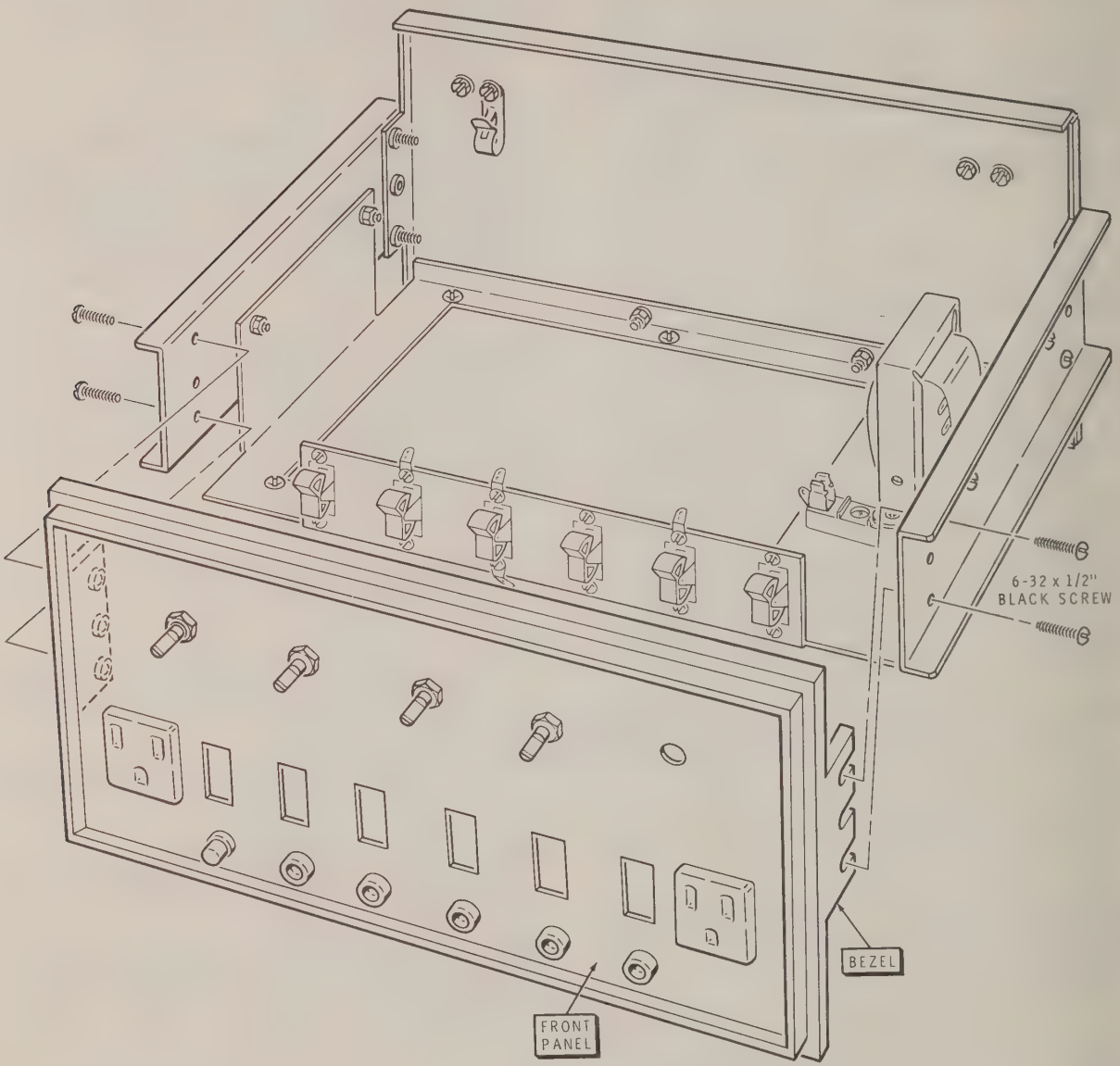
(✓) Refer to Detail 14A and prepare the end of the 3-wire line cord.

(✓) Pass the 3-wire line cord through hole CF in the rear panel and under the chassis as shown in the inset drawing on Pictorial 14.

(✓) Connect the ribbed wire of the 3-wire line cord to lug 1 of AC socket BG (NS).

(✓) Connect the middle (green) wire of the 3-wire line cord to lug 2 of AC socket BG (NS).

(✓) Connect the other wire of the 3-wire line cord to lug 3 of AC socket BG (NS).



PICTORIAL 15

FRONT PANEL INSTALLATION AND WIRING

(✓) Position the front panel and bezel in place and check to see that the rocker switches operate freely. If a switch rubs against the front panel, loosen the switch mounting screws and reposition the switch. Then tighten the mounting screws.

(✓) Refer to Pictorial 15 and mount the bezel and front panel to the side rails with 6-32 x 1/2" black screws.

Refer to Pictorial 16 (fold-out from Page 25) for the following steps.

(✓) Connect the green wire from BO#3 to lug 2 of AC socket BA (S-1).

Connect the wires from BO#4 to rotary switch BB as follows:

(✓) Both white-blue to lug 8 (S-2).

(✓) Both yellow to lug 6 (S-2).

(✓) White-orange to lug 4 (S-1).

(✓) White-brown to lug 2 (S-1).

(✓) White-gray to lug 12 (NS).

(✓) White-green to lug 10 (S-1).

(✓) Cut each lead of a 5600 Ω (green-blue-red) resistor to a length of 3/4".

(✓) Connect this resistor between lugs 12 (NS) and 7 (S-1) of rotary switch BB. Be sure the resistor leads do not touch any of the other lugs.

(✓) Place a 3/4" length of small sleeving over one lead of a 200 pF resin capacitor. Connect this lead to lug 12 of rotary switch BB (S-3). Connect the other lead of the capacitor to lug 1 of control BC (NS).

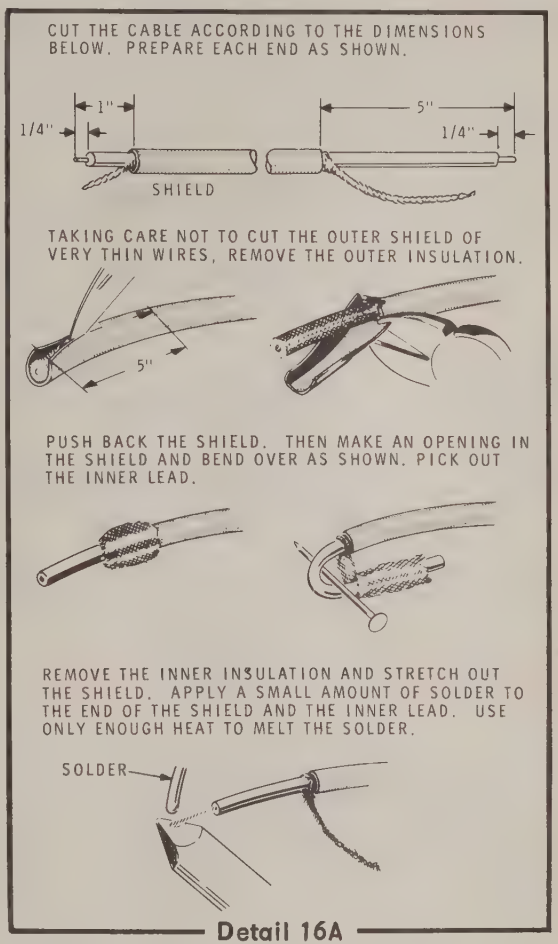
(✓) Connect the gray wire from BO#4 to lug 2 of control BC (S-1).

(✓) Connect the orange wire from BO#6 to lug 3 of control BC (S-1).

(✓) Connect the brown wire from BO#7 to lug 5 of control BD (S-1).

(✓) Connect the red wire from BO#7 to lug 4 of control BD (S-1).

( ) Connect the green wire from BO#8 to lug 2 of AC socket BG (NS).


CUT THE CABLE ACCORDING TO THE DIMENSIONS BELOW. PREPARE EACH END AS SHOWN.
1/4"
1"
SHIELD
5"
1/4"
TAKING CARE NOT TO CUT THE OUTER SHIELD OF VERY THIN WIRES, REMOVE THE OUTER INSULATION.
5"
PUSH BACK THE SHIELD. THEN MAKE AN OPENING IN THE SHIELD AND BEND OVER AS SHOWN. PICK OUT THE INNER LEAD.
REMOVE THE INNER INSULATION AND STRETCH OUT THE SHIELD. APPLY A SMALL AMOUNT OF SOLDER TO THE END OF THE SHIELD AND THE INNER LEAD. USE ONLY ENOUGH HEAT TO MELT THE SOLDER.
SOLDER
Detail 16A

(✓) Refer to Detail 16A and prepare both ends of the shielded cable.

(✓) Route the 1" prepared end of the cable through hole CG in the rear panel and under the chassis as shown in inset drawing #1 on Pictorial 16.

(✓) Connect the inner lead of the shielded cable to lug 6 of switch AD (S-1).

(✓) Connect the shield of the shielded cable to the solder lug on switch AD (NS).

(✓) Locate the orange and yellow wires that were cut from the large wiring harness and cut a 3-1/2" length from each wire. Save the remaining lengths of the yellow and orange wires, they will be used later.

(✓) Remove 1/4" of insulation from the ends of the orange and yellow wires if the ends are not already bare. Then twist the wires together approximately two full turns per inch.

(✓) Connect the yellow wire at one end of the twisted pair to lug 3 of switch AD (S-1).

(✓) Connect the orange wire at the same end of the twisted pair to the solder lug at switch AD (S-2).

(✓) Connect the yellow wire at the other end of the twisted pair to lug 2 of control BE (S-1).

(✓) Connect the orange wire of the twisted pair to lug 1 of control BE (NS).

(✓) Locate the remaining yellow and orange wires that were cut from the large wiring harness. Twist these wires together, approximately two full turns per inch. Remove 1/4" of insulation from both ends of each wire, if the ends are not already bare.

(✓) Connect the yellow wire of the twisted pair to lug 3 of control BE (S-1).

(✓) Connect the orange wire of the twisted pair to lug 1 of control BE (NS).

The other end of the twisted pair will be connected later.

(✓) Connect one end of a 4-1/2" bare wire to lug 1 of switch AE (S-1). Pass the other end through lug 1 of switch AF (NS), through lug 1 of switch AG (S-2), to lug 2 of AC socket BG (S-3).

NOTE: The bare wire in the next two steps will be soldered to the case at the back of the control.

(✓) Connect one end of a 2-3/4" bare wire to lug 1 of switch AF (S-3). Pass the other end through the solder lug at switch AF (S-2), to the case of control BE (S-2), and to lug 1 of control BE (S-3).

(✓) Connect a 2" bare wire from the solder lug at switch AB (S-1), to the case of control BC (S-2), to lug 1 of control BC (S-2).

(✓) Place a 3/4" length of sleeving over the positive (+) lead of the 10 μF tubular electrolytic capacitor, and connect the lead to lug 9 of switch AD (S-1).

(✓) Place a 1-1/2" length of sleeving over the other lead of the 10 μF electrolytic capacitor and connect the lead to lug 2 of control BD (S-1).

Refer to inset drawing #2 on Pictorial 16 for the following steps.

Connect the wires from BO#4 to rotary switch BB as follows:

(✓) Both blue to lug 5 (S-2).

(✓) Brown to lug 3 (S-1).

(✓) Black to lug 1 (S-1).

(✓) White-violet to lug 11 (S-1).

(✓) Red to lug 9 (S-1).

Refer to Detail 16B for the following steps.

(✓) Connect the free end of the red wire from lug 2 of the power transformer to lug 1 of AC socket BG (S-3).

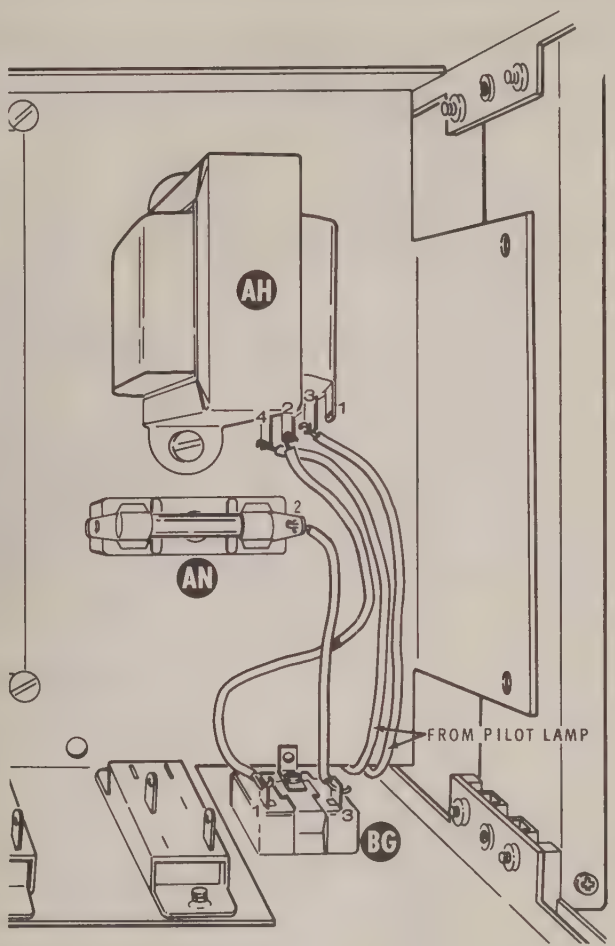
(✓) Remove 3" from the end of both pilot-lamp leads. Save one of the cut-off leads. It will be used in the next step.

(✓) Remove 1/4" of insulation from each end of the cut-off lead. Connect this lead from lug 2 of fuse block AN (S-1) to lug 3 of AC socket BG (S-3).

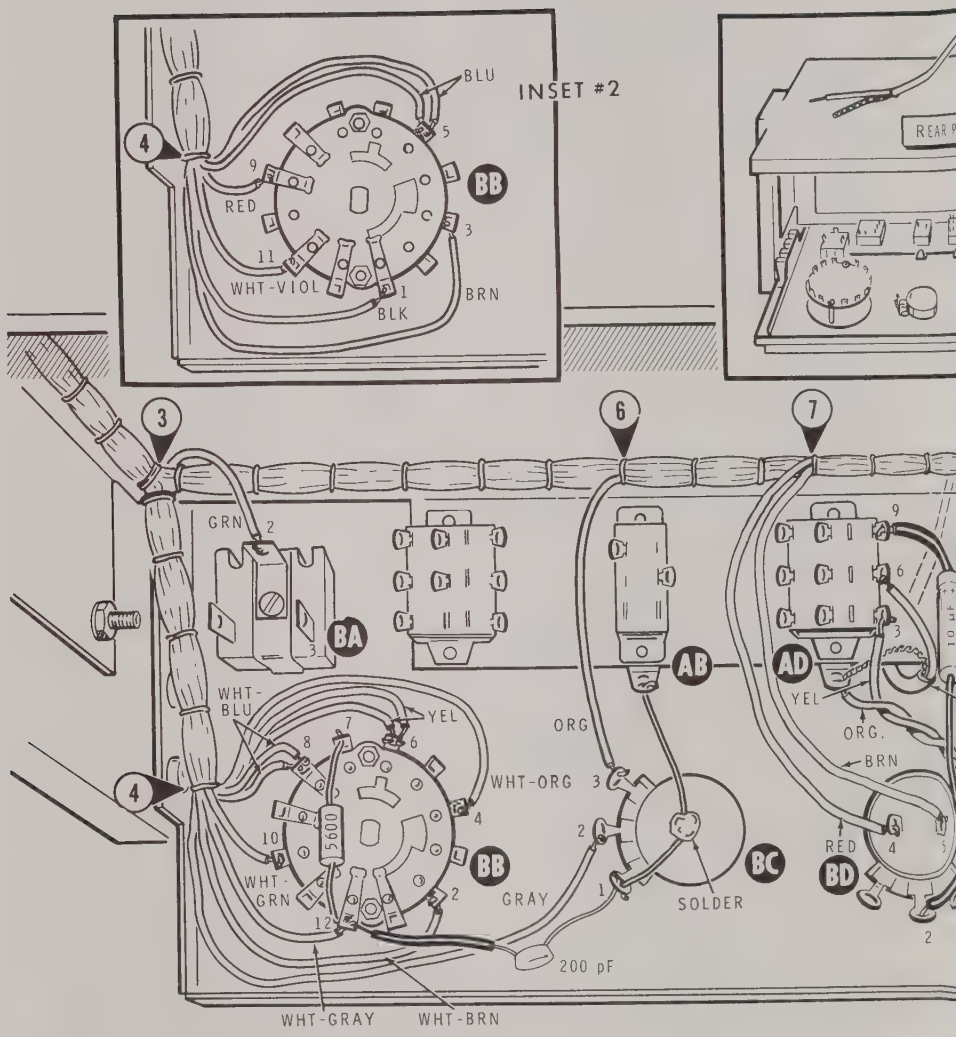
(✓) Remove 1/4" of insulation from the end of one pilot-lamp lead and connect the lead to lug 4 of power transformer AH (S-2).

(✓) Remove 1/4" of insulation from the remaining pilot-lamp lead and connect the lead to lug 3 of power transformer AH (S-2).

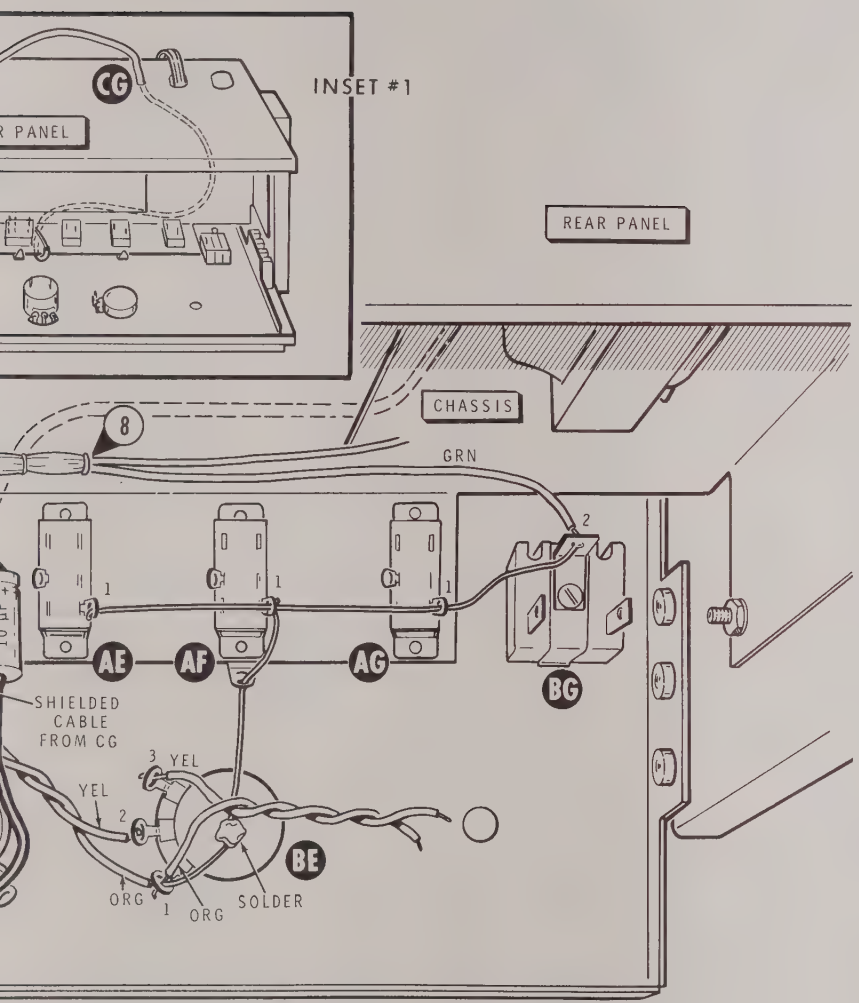
(✓) Install the fuse in the fuse block.



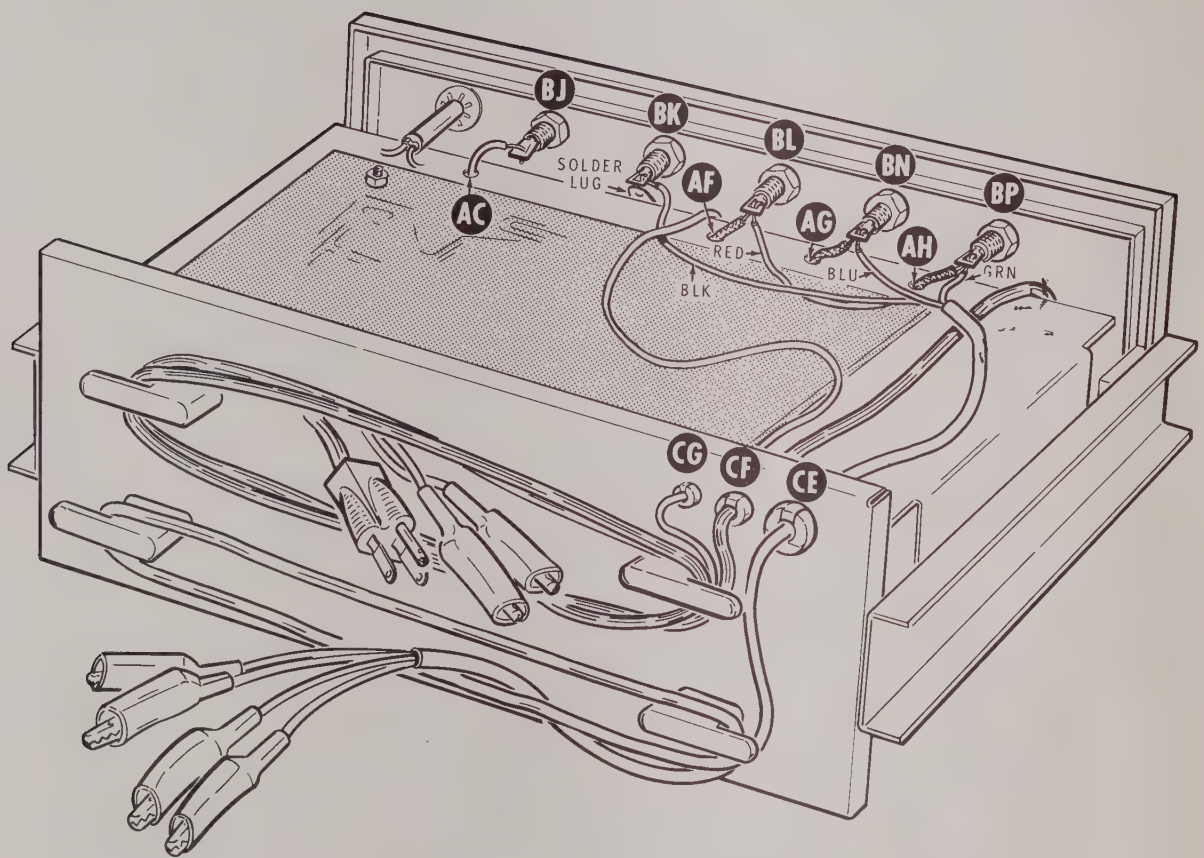
Detail 16B


INSET #2
BLU
5
9
RED
11
WHT-VIOL
1
BLK
BRN
3
BB
4
REAR
3
6
7
GRN
2
BA
AB
AD
9
6
3
YEL
ORG
BRN
WHT-
BLU
YEL
7
8
6
WHT-ORG
3
4
10
5600
WHT-
GRN
12
2
BB
GRAY
2
1
SOLDER
BC
RED
BD
4
5
2
200 pF
WHT-GRAY
WHT-BRN

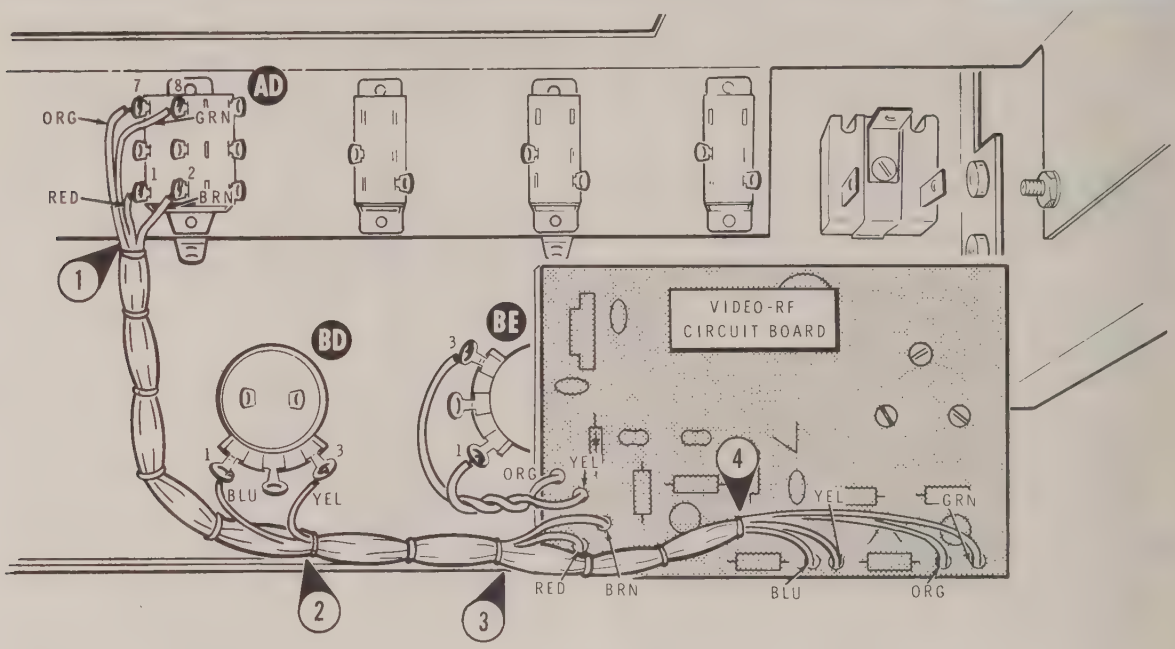
PICTOR


INSET #1
CG
R PANEL
REAR PANEL
CHASSIS
8
GRN
2
1
1
1
AE
AF
AG
BG
SHIELDED
CABLE
FROM CG
3 YEL
YEL
2
BE
ORG
1
ORG
SOLDER

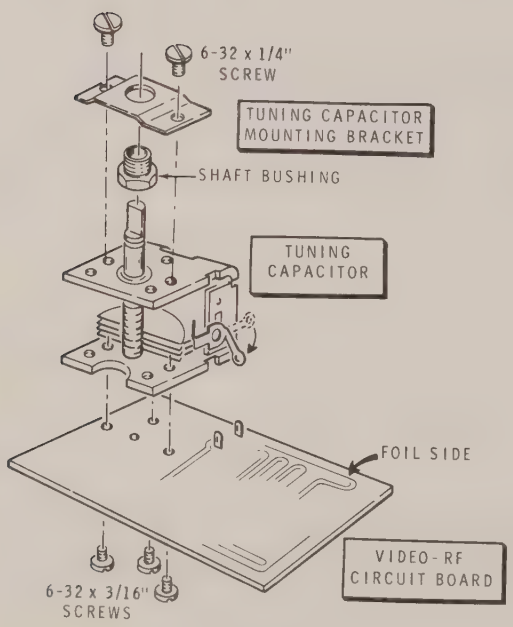
RIAL 16



PICTORIAL 18



PICTORIAL 17



Detail 17A

Refer to Detail 17A for the next two steps.

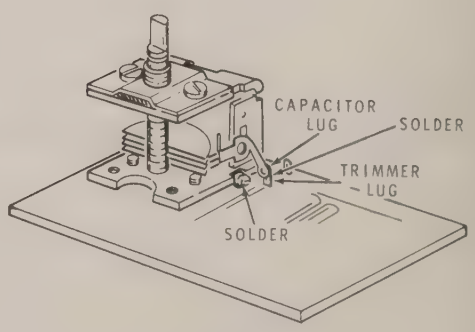
(✓) Insert the shaft bushing through the tuning capacitor mounting bracket. Then mount the tuning capacitor mounting bracket to the tuning capacitor with two 6-32 x 1/4" screws.

(✓) Mount the Video-RF circuit board to the tuning capacitor with three 6-32 x 3/16" screws as shown. Bend the tuning capacitor lug as shown.

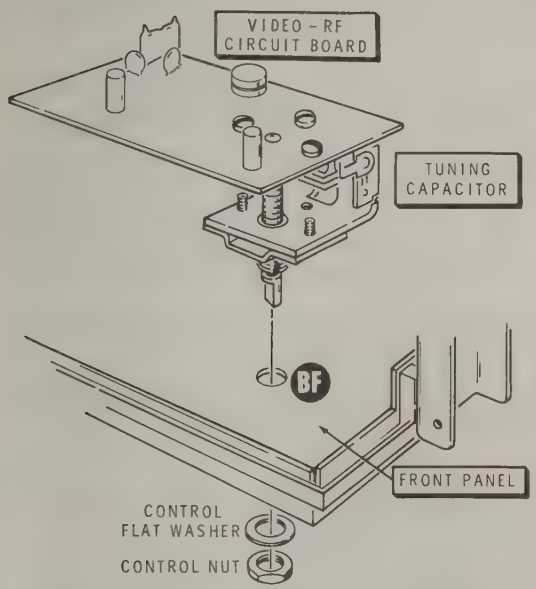
Refer to Detail 17B for the next two steps.

(✓) Solder the tuning capacitor lug to the trimmer lug.

(✓) Solder the frame of the tuning capacitor to the foil on the circuit board.



Detail 17B



Detail 17C

(✓) Refer to Detail 17C and mount the tuning capacitor at BF on the front panel with a control flat washer, and a control nut. Position the Video-RF circuit board as shown.

Refer to Pictorial 17 for the following steps.

Connect the free end of the twisted pair of wires from control BE to the Video-RF circuit board as follows:

(✓) Orange to ORG (S-1).

(✓) Yellow to YEL (S-1).

(✓) Locate the small wiring harness (#134-192) and position it so the wires at BO#1 and 2 are positioned as shown.

(✓) Connect the blue wire from BO#2 of the small wiring harness to lug 1 of control BD (S-1).

(✓) Connect the yellow wire from BO#2 of the small wiring harness to lug 3 of control BD (S-1).

Connect the wires from BO#1 of the small wiring harness to switch AD as follows:

(✓) Orange wire to lug 7 (S-1).

(✓) Green wire to lug 8 (S-1).

(✓) Red wire to lug 1 (S-1).

(✓) Brown wire to lug 2 (S-1).

Connect the wires from BO#3 of the small wiring harness to the Video-RF circuit board as follows:

(✓) Red to RED (S-1).

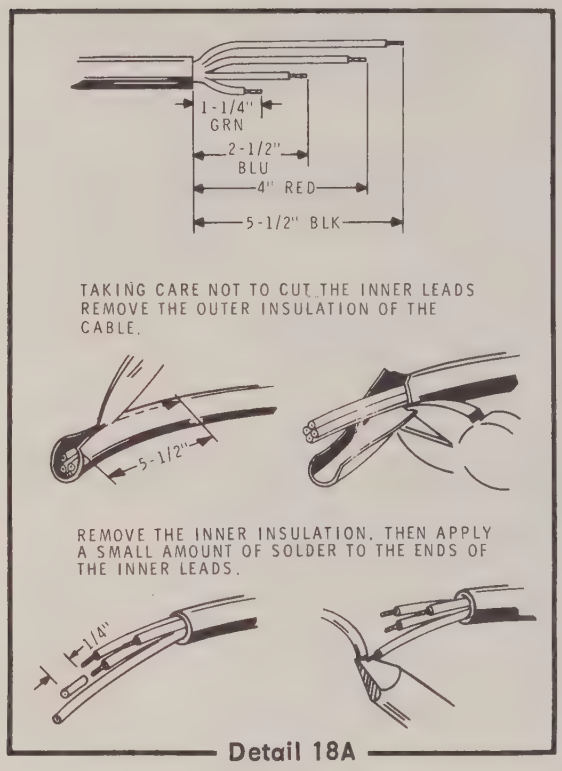
(✓) Brown to BRN (S-1).

(✓) Blue to BLU (S-1).

(✓) Yellow to YEL (S-1).

(✓) Orange to ORG (S-1).

(✓) Green to GRN (S-1).


1-1/4" GRN
2-1/2" BLU
4" RED
5-1/2" BLK
TAKING CARE NOT TO CUT THE INNER LEADS REMOVE THE OUTER INSULATION OF THE CABLE.
5-1/2"
REMOVE THE INNER INSULATION. THEN APPLY A SMALL AMOUNT OF SOLDER TO THE ENDS OF THE INNER LEADS.
1/4"

Detail 18A

Refer to Pictorial 18 (fold-out from Page 26) for the following steps.

(✓) Position the chassis assembly as shown.

(✓) Connect the white wire from hole AC to white banana jack BJ (S-1).

(✓) Refer to Detail 18A and prepare one end of the 4-wire cable as shown.

(✓) Pass this end of the 4-wire cable through hole CE in the rear panel.

NOTE: In the next step, the solder lug under black banana jack BK will be soldered to the black banana jack lug.

(✓) Connect the black wire from the 4-wire cable and the solder lug to black banana jack BK (S-2).

(✓) Connect the red wire from the 4-wire cable to red banana jack BL (NS).

(✓) Connect the blue wire from the 4-wire cable to blue banana jack BN (NS).

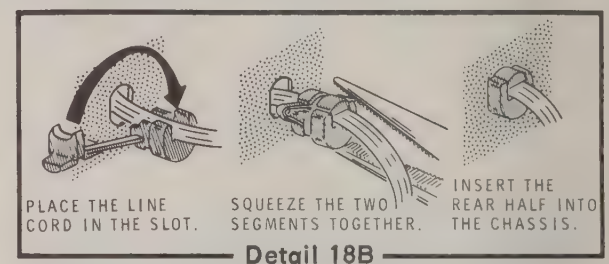
(✓) Connect the green wire from the 4-wire cable to green banana jack BP (NS).

(✓) Place a 1" length of sleeving over each resistor lead extending from holes AF, AG, and AH. Be sure the sleeving passes through the holes in the chassis to completely insulate the resistor leads from the chassis.

(✓) Connect the resistor lead from hole AF to red banana jack BL (S-2).

(✓) Connect the resistor lead from hole AG to blue banana jack BN (S-2).

(✓) Connect the resistor lead from hole AH to green banana jack BP (S-2).



Detail 18B

Refer to Detail 18B for the following steps.

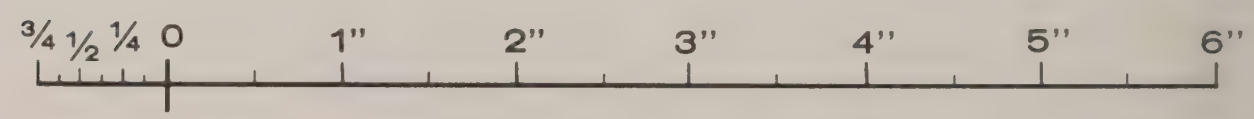
(✓) Install the 4-wire cable strain relief on the 4-wire cable at CE.

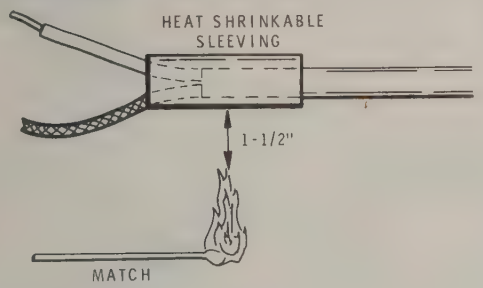
(✓) In the same manner, install the small shielded cable strain relief on the shielded cable at CG.

NOTE: At this time you should have two line cord strain reliefs of the same size left. One of these is for the flat line cord included with this kit. The other strain relief is to be used only if a round line cord (applicable in foreign countries and not included with this kit) is used.

(✓) Install the line cord strain relief on the line cord at CF.

Refer to Detail 18C for the next three steps.

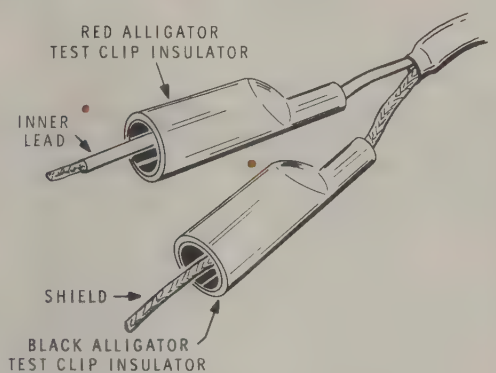




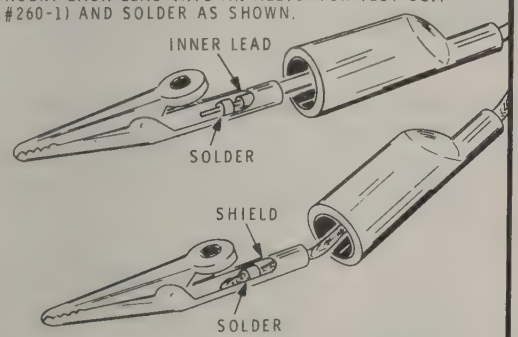
(1) CENTER THE SLEEVING OVER THE LEADS AND THE OUTER CABLE INSULATION.

(2) USE THE HEAT FROM A MATCH TO SHRINK THE SLEEVING. ROTATE THE CABLE TO SHRINK THE SLEEVING EVENLY.

SLIP THE RED AND BLACK ALLIGATOR TEST CLIP INSULATORS ONTO THE INDICATED LEADS.



INSERT EACH LEAD INTO AN ALLIGATOR TEST CLIP (#260-1) AND SOLDER AS SHOWN.



Detail 18C

(✓) Cut the length of heat shrinkable sleeving in half and install it on the shielded cable as shown.

(✓) Push the red alligator clip insulator onto the inner (clear) lead of the shielded cable and a black alligator clip insulator onto the shield lead.

(✓) Install the plain alligator clips (not the lead piercing clips) on the inner lead and shield lead of the shielded cable. Then push the insulators down over the clips as shown.

Refer to Detail 18D for the following steps.

(✓) Remove 5" of outer insulation from the free end of the 4-wire cable. Then remove 1/4" of insulation from the end of each wire.

(✓) Locate the remaining length of heat shrinkable sleeving and install it on the 4-wire cable as shown. It may be necessary to stretch the sleeving to allow it to pass over the outer insulation of the cable.

(✓) Push a black alligator clip insulator onto each lead.

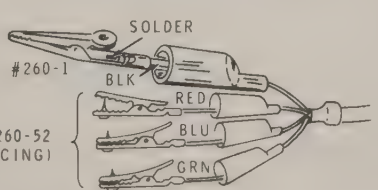
(✓) Install the remaining plain alligator clip (not the lead piercing clip) on the black wire of the 4-wire cable. Then push the insulator down over the clip.

(✓) Install lead piercing alligator clips on the remaining leads of the 4-wire cable. Then push the insulators down over the clips as shown.

CUT THE CABLE ACCORDING TO THE DIMENSIONS BELOW. PREPARE THE END AS SHOWN.

SLIP THE LENGTH OF HEAT SHRINKABLE SLEEVING ONTO THE 5" END OF THE CABLE. POSITION THIS SLEEVING APPROXIMATELY 1/2" OVER THE OUTER INSULATION. HEAT LONG ENOUGH TO SHRINK THE SLEEVING TIGHTLY AROUND THE CABLE.

SLIP AN ALLIGATOR TEST CLIP INSULATOR ONTO EACH LEAD AT THE 5" END OF THE CABLE. INSERT THE PROPER LEAD INTO THE INDICATED ALLIGATOR TEST CLIP AND SOLDER.



Detail 18D

NOTE: The line cord is equipped with a polarized plug. Therefore, an adapter has been included in case your house wiring is not equipped with polarized sockets. When you use this adapter, the green wire should be connected under a screw that is connected to earth ground.

This completes the wiring of your Color Bar And Dot Generator. Carefully inspect the circuit board to be sure all connections are properly soldered, and that no solder bridges exist across adjacent foils, especially around the IC sockets. Also examine the chassis wiring to be sure there are no wire clippings or solder splashes lodged in the wiring or across any connections.

Proceed to the Handle And Knob Installation section that follows.

HANDLE AND KNOB INSTALLATION

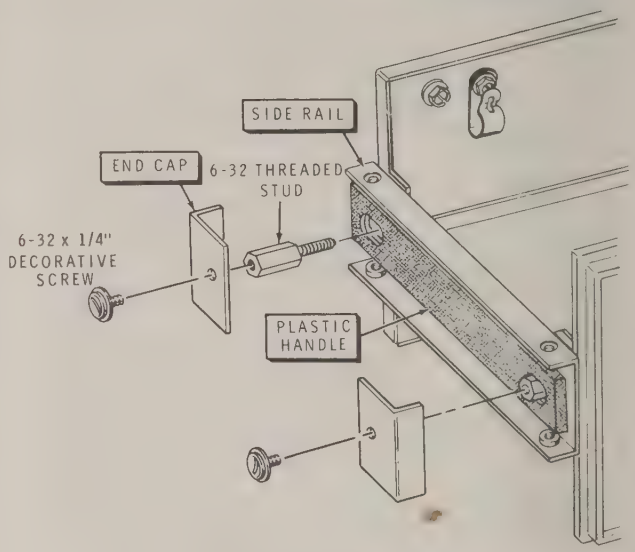
Refer to Pictorial 19 for the following steps.

(√) Install the threaded studs in both side rails as shown.

(√) Place the plastic handles over the threaded studs with the grained side out. Then install the end caps with four 6-32 x 1/4" decorative screws.

Refer to Pictorial 20 and Detail 20A for the following steps.

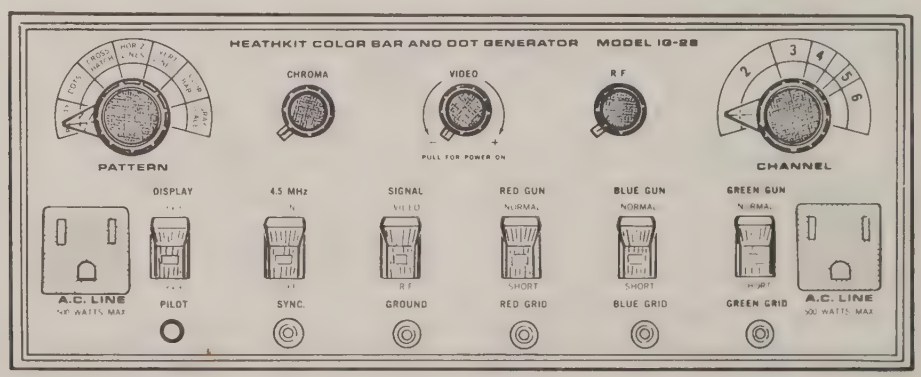
( ) Turn all of the control shafts on the front panel to their full counterclockwise position.



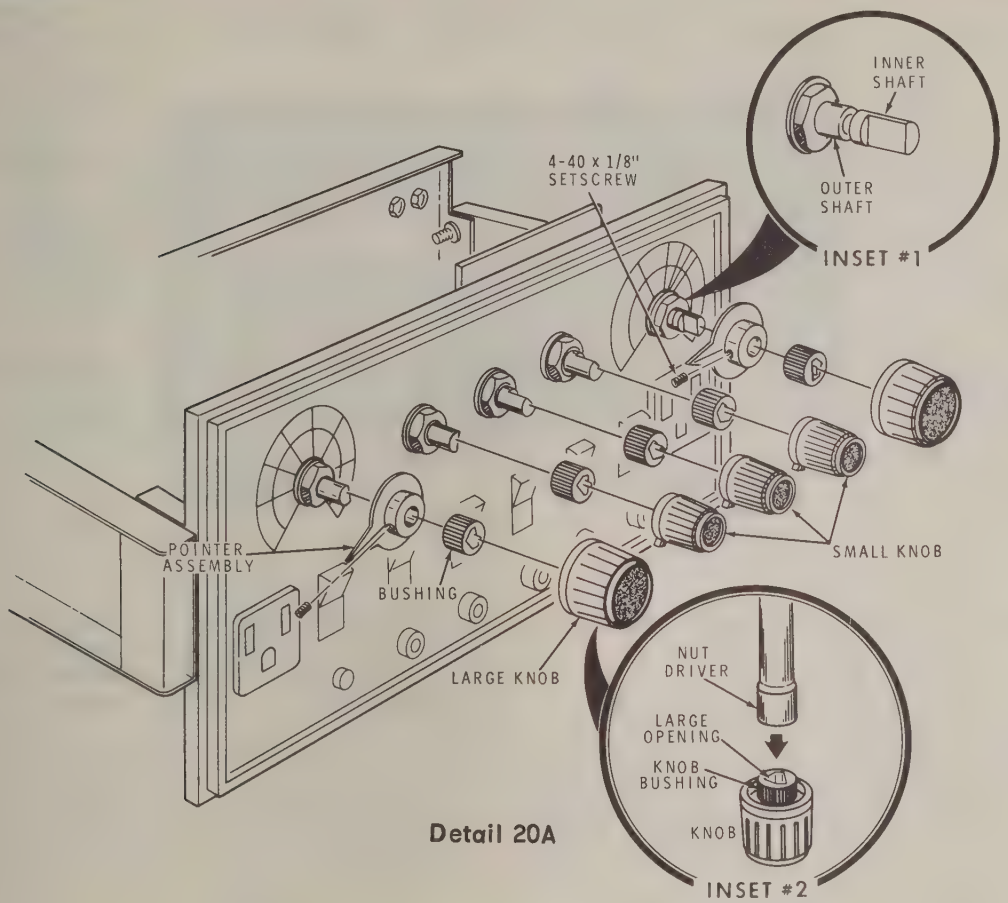
PICTORIAL 19

( ) Use the allen wrench and start a 4-40 x 1/8" setscrew in one of the dial pointers. Push the dial pointer all the way onto the Pattern switch shaft. Position the dial pointer as shown and tighten the setscrew.

( ) In the same manner, start a 4-40 x 1/8" setscrew in the remaining dial pointer. Push the dial pointer all the way onto the Channel tuning shaft. NOTE: There is an outer shaft and an inner shaft. Install the pointer on the outer shaft. Refer to inset drawing #1 on Detail 20A.



PICTORIAL 20



Detail 20A

(✓) Push a knob insert onto the Pattern switch shaft. Then press a large knob part way onto the insert.

(✓) Remove both the knob and knob insert. Do not allow the knob to come off the insert. Refer to inset drawing #2 on Detail 20A and press the insert all the way into the knob cavity with a nutdriver or other suitable instrument. Replace the knob on the Pattern switch shaft.

(✓) In the same manner, install the remaining large knob on the Channel tuning shaft.

(✓) Install the small knobs on the Chroma, Video and R.F. control shafts. Position the knobs so their pointers are as shown.

Proceed to the Test And Adjustment section that follows.

TEST AND ADJUSTMENT

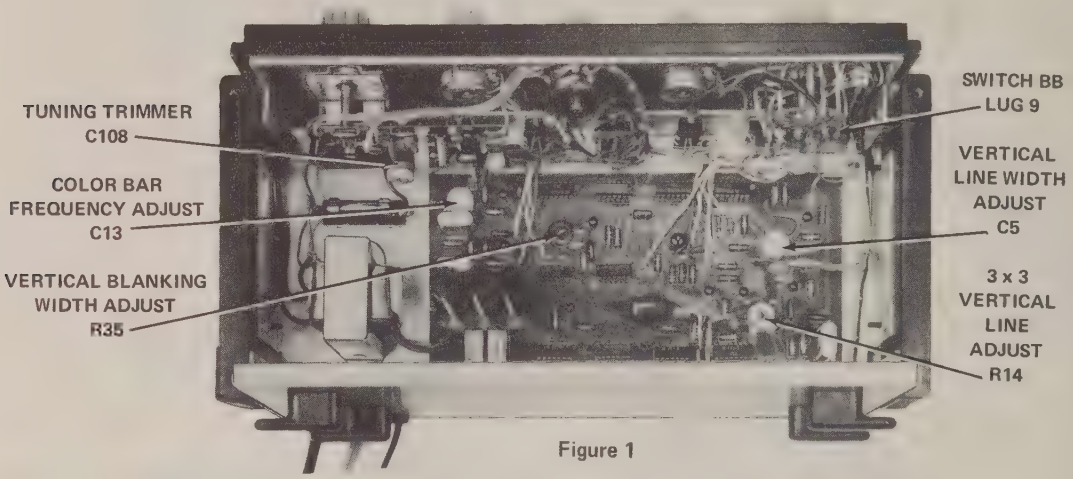


Figure 1

Refer to Figure 1 for the following steps.

In this section of the Manual you will test the operation of your Color Bar And Dot Generator and make necessary adjustments before you complete the Final Assembly. If any trouble is encountered in the following tests or adjustments, turn the power off and refer to the In Case Of Difficulty section on Page 50.

NOTE: The internal wiring of most ohmmeters is such that the positive terminal of the meter battery is connected to the positive (red) test lead and the negative battery terminal is connected to the negative (black) test lead. In some ohmmeters this wiring is reversed, and erroneous readings will be obtained when making the following measurements. Try reversing the ohmmeter leads if the measurements do not check out correctly at first.

The following test was made with an ohmmeter having a 1-1/2 volt battery. If your ohmmeter has a larger battery than this, it may cause the zener diode to conduct; which, in turn, could cause the resistance reading to be considerably less than those listed below.

( ) If an ohmmeter is available, measure the resistance between lug 9 of rotary switch BB and chassis ground with the ohmmeter set on the Rx100 range. The reading should be 200 Ω or higher. A very low resistance reading (100 Ω or less) could indicate a solder bridge between two adjacent foils on the circuit board or perhaps a diode installed incorrectly.

( ) Connect the ohmmeter between the GROUND (black) and the RED GRID (red) connectors. With the RED GUN switch in the SHORT position the reading should be 100 kΩ.

( ) Repeat the procedure with the BLUE GRID connector.

( ) Repeat the procedure with the GREEN GRID connector.

( ) Turn on the TV receiver.

( ) Tune a color telecast on any channel from 2 through 6 on an operating color television receiver.

( ) Carefully adjust the receiver horizontal and vertical hold controls for a locked-in picture.

( ) Adjust the tint control of the receiver to produce the correct color for the picture displayed. Do not change the setting of the tint, horizontal, or vertical hold controls for the balance of this test procedure.

NOTE: You may have to readjust the horizontal hold on some receivers to prevent distortion.

Set the controls on the front panel of the Generator as follows:

( ) PATTERN - HORIZ LINES

( ) CHROMA - Mid-range position

( ) VIDEO level - Any position

( ) R.F. level - Fully clockwise

( ) POWER - OFF

( ) CHANNEL - Fully counterclockwise

( ) DISPLAY - 9x9

( ) 4.5 MHz - OFF

( ) SIGNAL - R.F.

( ) RED GUN - NORMAL

( ) BLUE GUN - NORMAL

( ) GREEN GUN - NORMAL

( ) Disconnect the TV receiver antenna and connect the generator shielded output cable to the antenna input terminals of the receiver. The 4-wire cable will be connected to the receiver later.

( ) Turn off AFT (Automatic Fine Tuning) if your TV receiver is equipped with it.

( ) Turn the CHANNEL tuning of the Generator to the same channel as the television receiver.

( ) Plug the Generator line cord into an AC outlet of the proper voltage (120 or 240 VAC, depending upon the connection of the power transformer primary winding).

( ) Pull the Generator POWER switch to ON.

NOTE: Use the alignment tool for the following trimmer adjustments. Use the access hole in the rear panel for the next adjustment.

( ) Slowly turn trimmer capacitor C108 (on the Video -RF circuit board). As the trimmer is slowly rotated, a pattern will appear on the TV screen. There should be eight to ten horizontal lines in the pattern.

( ) Turn the PATTERN switch to CROSSHATCH.

NOTE: In the following steps, keep the brightness control on the receiver at a low level to prevent blooming (wide, unfocused lines). It is normal for the vertical lines to be wider than the horizontal lines.

( ) Turn R35 to full counterclockwise position.

( ) Adjust trimmer capacitor C5 until horizontal and vertical lines of approximately the same intensity appear on the screen.

( ) Note the intensity of the vertical lines on the screen, then switch the DISPLAY switch to 3 x 3. Adjust control R14 so that the vertical lines on the screen are the same intensity as the 9 x 9 pattern. Switch back and forth between the 3 x 3 and 9 x 9 pattern several times to obtain the correct intensity.

NOTE: For the following adjustment, the television brightness control may have to be turned up slightly.

( ) Turn R35 clockwise until the vertical retrace lines become visible in the upper portion of the television picture tube. Then turn R35 just far enough counterclockwise for the retrace lines to disappear.

( ) Rotate the RF Level control through its full range. This should simulate a weak to a very strong signal to the receiver.

( ) Turn the PATTERN switch to COLOR BAR.

( ) Set the RF Level control to the center of its range.

( ) Set the DISPLAY switch to 3 x 3.

NOTE: When tuning the CHANNEL control, always start at the lower end of the band and tune clockwise. The first clockwise position that produces a display on the TV screen is the correct position.

( ) Fine tune the CHANNEL control to produce color in the bars. If the bars do not appear in color, adjust trimmer capacitor C13 to produce color and minimize ripple in the color bars. A small amount of ripple is normal due to the generator off-set carrier oscillator frequency.

( ) Switch the DISPLAY switch to 9 x 9.

NOTE: There should be 10 color bars displayed on the screen. Normally you will only see 8 or 9 bars due to overscan of the TV receiver. If ten color bars are seen, the third bar from the left should appear red, the sixth bar should appear blue, the ninth bar should appear blue-green, and the tenth bar should appear green. Due to the various degrees of phase angle between the two color demodulators of television receivers, the third bar may not always be a solid red color. Therefore adjust capacitor C13 so that the fifth and the seventh bars are approximately the same off-shade blue and the sixth bar is the most solid blue. Even though the third bar may not appear as the best red at this setting, Q13 will be adjusted properly. If only eight bars are displayed, count one less for the above bar designation.

( ) Rotate the PATTERN switch to each of its seven positions. The patterns indicated in Figure 2A (fold-out from Page 37) should appear on the receiver screen.

( ) Set the DISPLAY switch to the 3x3 position and again rotate the PATTERN switch through each of the seven positions. The patterns indicated in Figure 2B (fold-out from Page 37) should appear on the receiver screen.

CAUTION: To avoid the danger of a shock, turn off your television receiver before proceeding to the next step. The alligator clips at the end of the 4-wire cable will be connected to your receiver in the following steps. If you are not sure of the proper connecting points in your receiver, refer to the schematic diagram and picture tube basing chart. The alligator clips are identified by their wire colors.

NOTE: In some TV receivers the chrominance signal is applied to the cathode instead of the grid of the picture tube. On such a receiver, the red, blue, and green gun switches have no effect on the color. In these cases the red, blue, and green gun switches on the generator can be checked by connecting an ohmmeter between the black lead and the red, blue, or green lead. Each lead should measure 100 kΩ with the respective switch in the SHORT position and infinite with the switch in the NORMAL position.

( ) Connect the black clip to a ground point on the TV receiver. (This is normally the chassis.)

( ) Connect the three lead-piercing alligator clips to their respective color control grid-leads of the receiver picture tube socket. (Red to the red control grid, etc.) Be sure the point on the alligator clip pierces the insulation of the lead it is connected to. NOTE: Color picture tube sockets are usually wired with a solid color wire for each of its control grids. For example, a solid green wire would normally be the green control grid wire. Check the tube basing chart to be sure.

( ) Turn the television receiver on again and turn the PATTERN switch of the Generator to COLOR BAR.

( ) As each color gun switch is placed in the SHORT position, that color should disappear from the picture tube screen.

( ) Turn off the Generator and TV receiver and disconnect the test leads.

Two methods are provided for checking the Generator video-output signals. The clarity and detail of the oscilloscope patterns are directly related to the bandwidth and triggering of the oscilloscope used. If an oscilloscope is available, perform the steps under Method #1. If an oscilloscope is not available, perform the steps under Method #2.

METHOD #1

( ) Connect the shielded cable from the Generator to the vertical input of the oscilloscope.

( ) Set the Generator PATTERN switch to PURITY.

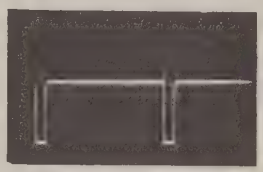
( ) Set the SIGNAL switch to VIDEO.

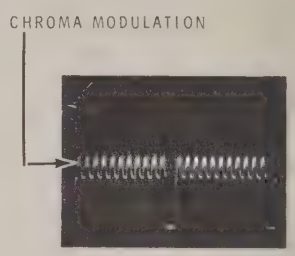
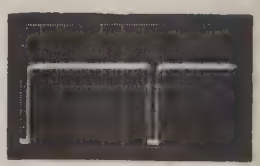
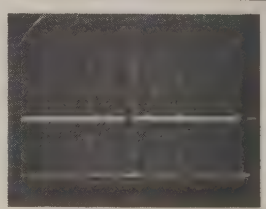
( ) Set the DISPLAY switch to 3x3.

( ) Set the Generator VIDEO control fully clockwise.

Perform the checks listed in the following chart.

SET GENERATOR CONTROLS AS FOLLOWS:	SET OSCILLOSCOPE CONTROLS AS FOLLOWS:	OSCILLOSCOPE PATTERN
PATTERN switch to PURITY	Horizontal sweep to 1/2 the vertical sweep rate of the TV receiver (30 Hz).	

SET GENERATOR CONTROLS AS FOLLOWS:	SET OSCILLOSCOPE CONTROLS AS FOLLOWS:	OSCILLOSCOPE PATTERN
PATTERN switch to PURITY	Horizontal sweep to 1/2 the horizontal sweep rate of the TV receiver (7920 Hz).	
PATTERN switch to DOTS		
PATTERN switch to CROSS-HATCH		
PATTERN switch to HORIZ LINES		
PATTERN switch to VERT LINES		
DISPLAY switch to 9x9		

SET GENERATOR CONTROLS AS FOLLOWS:	SET OSCILLOSCOPE CONTROLS AS FOLLOWS:	OSCILLOSCOPE PATTERN
PATTERN switch to COLOR BAR	Horizontal sweep to 1/2 the horizontal sweep rate of the TV receiver (7920 Hz).	
Vary the CHROMA control and notice the change in chroma modulation on the wave form. Then reset the control to mid-range.		
DISPLAY switch to 3x3		
PATTERN switch to GRAY SCALE DISPLAY switch to 9x9		
Disconnect the Generator from the oscilloscope. Connect the oscilloscope to the SYNC jack on the Generator front panel.		
	Horizontal sweep to 1/2 the vertical sweep rate of the TV receiver (30 Hz).	

METHOD #2

( ) Connect the shielded cable output leads of the Generator to the video detector output of the television receiver.

( ) Connect a wire from the SYNC jack on the generator front panel to the output of the Sync detector in the TV receiver.

( ) Set the SIGNAL switch to VIDEO.

Refer to the screen patterns on Figure 2A for the following steps.

( ) Set the PATTERN switch to PURITY. See pattern #1.

( ) Set the PATTERN switch to DOTS. See pattern #2.

( ) Rotate the VIDEO control through its entire range. The dots should change from black to white. Leave the control in the white dot position.

( ) Set the PATTERN switch to CROSSHATCH. See pattern #3.

( ) Set the PATTERN switch to HORIZ LINES. See pattern #4.

( ) Set the PATTERN switch to VERT LINES. See pattern #5.

( ) Set the PATTERN switch to COLOR BARS. See pattern #6.

( ) Turn the CHROMA control fully clockwise.

( ) Set the 4.5 MHz switch to ON, and note the herringbone in the color bar pattern.

( ) Set the 4.5 MHz switch to OFF.

( ) Set the PATTERN switch to GRAY SCALE. See pattern #7.

( ) Set the DISPLAY switch to 3x3.

( ) Set the PATTERN switch to PURITY.

( ) Turn the PATTERN switch through each position again and compare the TV patterns to the patterns shown in Figure 2B.

This completes the Test And Adjustment of the Color Bar And Dot Generator. Proceed to the Final Assembly steps that follow.

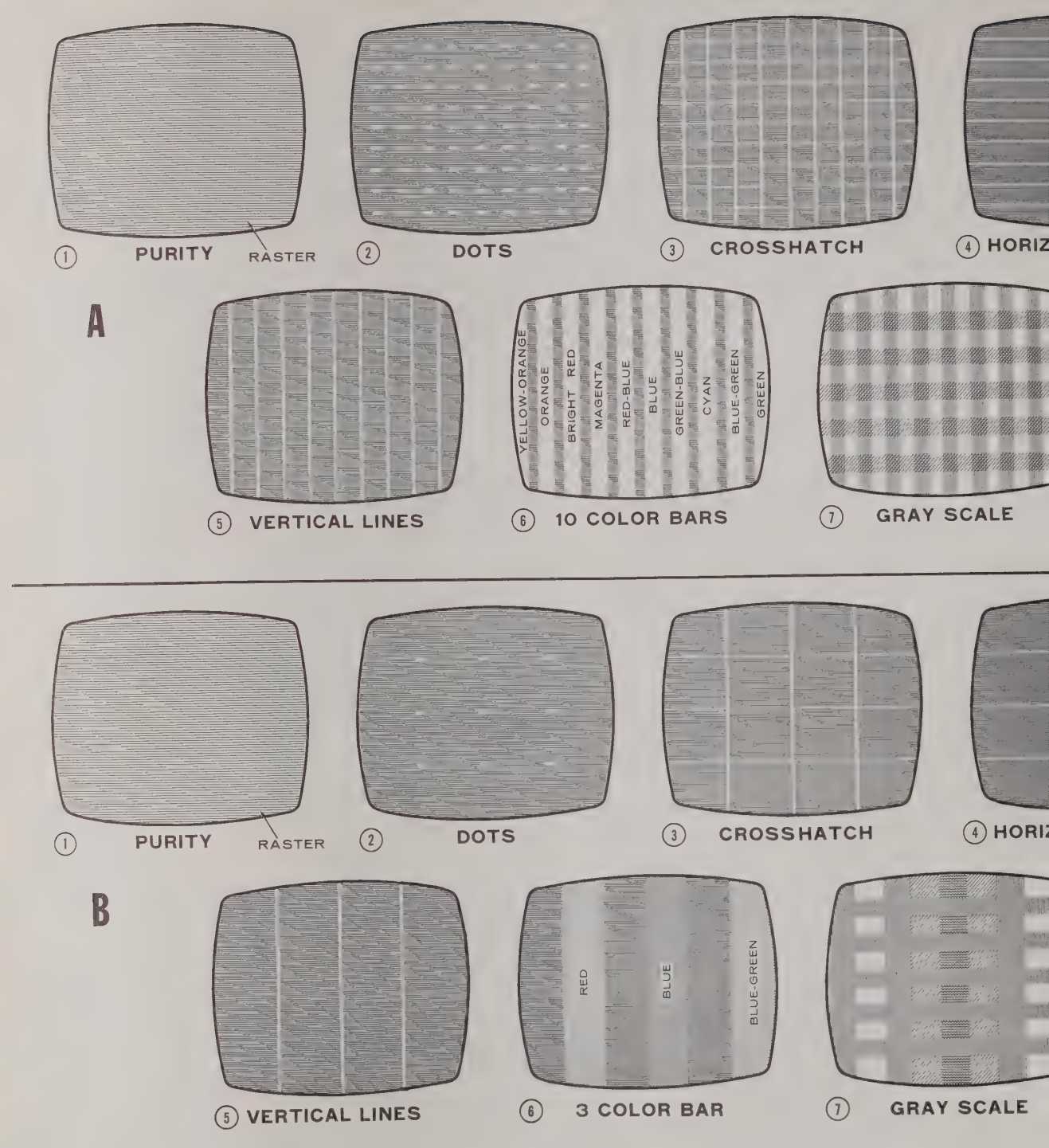
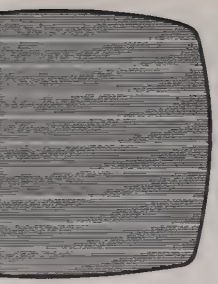
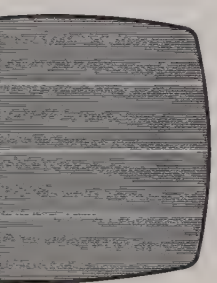

A
1 PURITY
RASTER
2 DOTS
3 CROSSHATCH
4 HORIZ
5 VERTICAL LINES
YELLOW-ORANGE
ORANGE
BRIGHT RED
MAGENTA
RED-BLUE
BLUE
GREEN-BLUE
CYAN
BLUE-GREEN
GREEN
6 10 COLOR BARS
7 GRAY SCALE
B
1 PURITY
RASTER
2 DOTS
3 CROSSHATCH
4 HORIZ
5 VERTICAL LINES
RED
BLUE
BLUE-GREEN
6 3 COLOR BAR
7 GRAY SCALE

FIGURE 2



ONTAL LINES



ONTAL LINES

CHROMA CONTROL

Controls the amount of color signal from the Generator.

VIDEO CONTROL AND OFF/ON SWITCH

Turns the Generator off or on and controls the video amplitude from negative to positive.

RF CONTROL

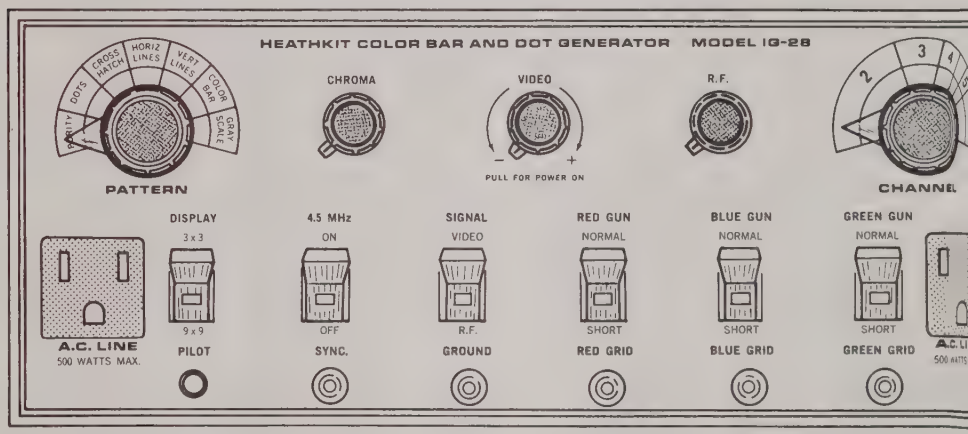
Controls the amount of RF signal from the Generator.

CHANNEL TUNING

Adjusts generator to pro frequency for TV channe through 6.

PATTERN SWITCH

Selects the pattern to be displayed on the television screen.
Purity - Purity adjustments.
Dots - Convergence adjustments.
Cross Hatch - Convergence and linearity adjustments.
Horiz. Lines - Vertical linearity and pin-cushion adjustments.
Vert. Lines - Horizontal linearity and convergence adjustments.
Color Bar - Demodulator phase adjustment.
Gray Scale - Color gun level adjustments.



DISPLAY SWITCH

Provides a 3 x 3 or 9 x 9 pattern on the TV screen.

4.5 MHz SWITCH

Provides a 4.5 MHz signal for sound trap adjustments.

SIGNAL SWITCH

Selects RF or video output signals.

RED, BLUE, AND GREEN

Each switch cuts off its re gun in the picture tube.

SYNC JACK

Provides sync signal for the television receiver when making video tests.

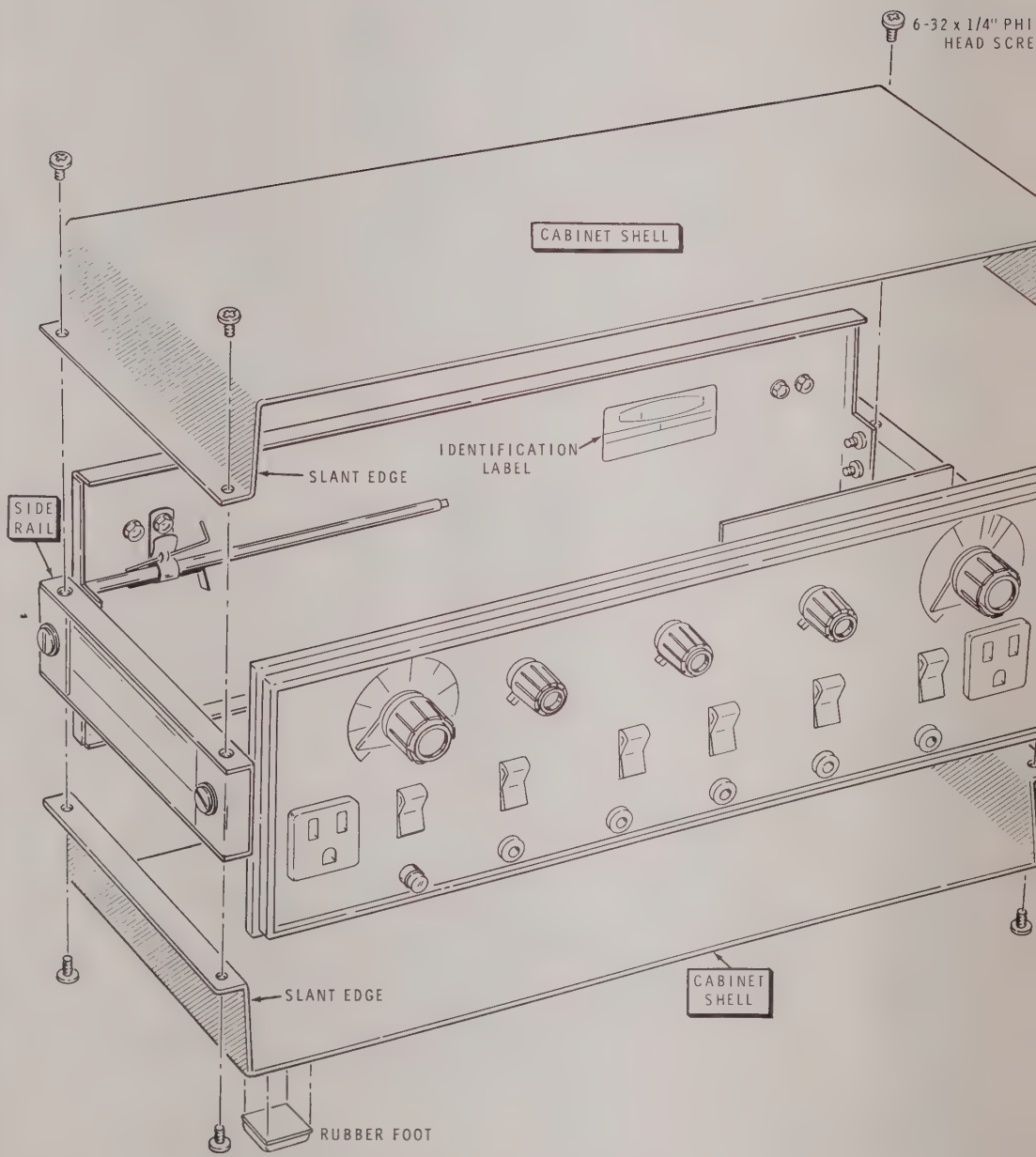
RED, BLUE, AND GREEN GRID JACKS

Supply waveforms from the individual CRT control grids.

AC SOCKET

Two unswitched AC sockets provide power for other equipment.

FIGURE 3



PICTORIAL 21

FINAL ASSEMBLY

Refer to Pictorial 21 (fold-out from this page) for the following steps.

NOTE: The blue and white identification label that is installed in the next step shows the Model number and Production Series number of your kit. Refer to these numbers in any communications with the Heath Company; this assures you that you will receive the most complete and up-to-date information in return.

( ) Carefully peel away the backing paper from the blue and white identification label. Then press the label into place on the inside surface of the rear panel as shown.

( ) Place the insulated screwdriver, allen wrench, and IC puller in the fahnestock clip for use at some future date.

( ) Mount the cabinet shells to the side rails as shown with 6-32 x 1/4" phillips head screws. Be sure to position the slant edge of the cabinet shells forward.

( ) Peel the backing paper from the rubber feet and press them into place on each corner of the bottom cabinet shell.

( ) Wrap the line cord and shielded cable around the two lower line cord retainers on the back of the Generator. Wrap the 4-wire cable around the two upper line cord retainers.

This completes the assembly of your Heathkit Color Bar And Dot Generator.

OPERATION

The Test And Adjustment section of this Manual introduced you to the operation of your Color Bar And Dot Generator. This Operation section will help you to obtain the greatest use of your instrument by directing you through the adjustments of a typical color television receiver.

The best procedure for receiver adjustments and servicing is normally provided by the receiver manufacturer. However, since all color or black and white receivers operate on the same principles, the general procedure presented here may be followed if manufacturer recommendations are not available.

Figure 3 (fold-out from this page) shows the control panel of the Color Bar And Dot Generator. Study the figure carefully to identify the function of each switch, control, jack and socket.

PRELIMINARY ADJUSTMENTS

( ) Completely degauss the picture tube and and metal parts around the tube.

The following preliminary adjustments must be made before you attempt other adjustments in your receiver.

( ) Tune the receiver to a channel transmitting a black and white program and adjust the brightness and contrast for the best possible picture. If necessary, adjust the focus control for sharply defined lines from the center to the edges of the screen.

( ) Turn the receiver to an unused channel from 2 through 6.

( ) Disconnect the TV VHF antenna.

( ) Connect the shielded cable from the Generator to the VHF antenna terminals of the receiver.

( ) Set the PATTERN switch to COLOR-BAR and turn on the Generator.

( ) Tune the Generator to the receiver. Remember to tune for color on the low side of the channel.

( ) Set the PATTERN switch to CROSSHATCH and the DISPLAY switch to 3x3.

( ) Adjust the vertical and horizontal centering controls of the receiver to center the crosshatch pattern on the screen.

NOTE: As a general rule the 3x3 display on any pattern is preferred for centering, linearity, and static convergence adjustments. A 9x9 display is preferred for dynamic convergence and over-all check of the sweep circuits. It is suggested that the display switch be tried in both positions to determine individual preference.

( ) Adjust the vertical linearity and height controls for uniform rectangles from the top to the bottom of the screen.

If the receiver contains a horizontal efficiency or width control, make any necessary adjustments to obtain a proper pattern on the screen.

( ) For sets with rectangular tubes, refer to the manufacturer's service data for the correct sequence for adjusting the pincushion controls to produce straight lines at the extreme top, bottom, and sides of the screen.

( ) Turn off the Generator and remove the test leads from the antenna terminals.

( ) Tune the receiver to a black and white program.

( ) Set the color intensity control to its mid-range setting.

( ) Adjust the color killer control until colored snow appears in the picture. Then turn the control in the opposite direction until the snow just disappears.

( ) Check all channels for colored snow. Turn the color killer control, if necessary, until the colored snow just disappears.

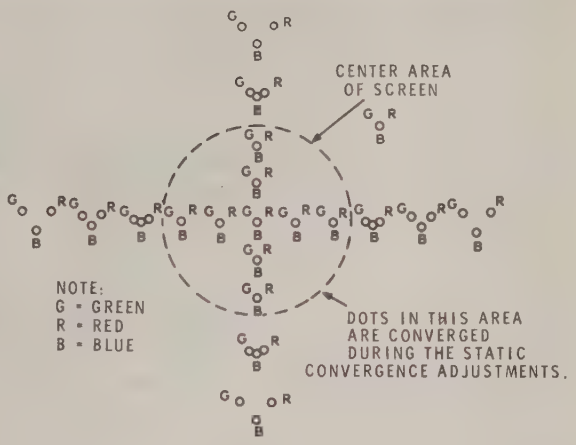

CENTER AREA OF SCREEN
NOTE:
G = GREEN
R = RED
B = BLUE
DOTS IN THIS AREA ARE CONVERGED DURING THE STATIC CONVERGENCE ADJUSTMENTS.

Figure 4

STATIC CONVERGENCE ADJUSTMENTS

The purpose of the static convergence adjustments is to converge the red, green, and blue dots to produce white dots in the middle of the screen. The static convergence magnets are effective only in the center area of the picture tube. See Figure 4. The dots in the other areas of the CRT are converged by the Dynamic Convergence adjustments.

Usually the static convergence must be performed before and after the purity adjustments, because a certain amount of interaction will occur between the two.

Refer to Figure 5 for the directions that the color dots will move when the static convergence magnets are adjusted.

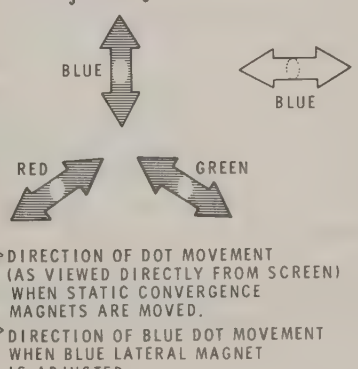

BLUE
BLUE
RED
GREEN
DIRECTION OF DOT MOVEMENT (AS VIEWED DIRECTLY FROM SCREEN) WHEN STATIC CONVERGENCE MAGNETS ARE MOVED.
DIRECTION OF BLUE DOT MOVEMENT WHEN BLUE LATERAL MAGNET IS ADJUSTED

Figure 5

( ) Connect the shielded cable of the Generator to the antenna VHF terminals of the receiver.

CAUTION: To avoid a possible electric shock, always turn off the television receiver before you connect or disconnect any leads to internal parts of the receiver.

NOTE: On some TV receivers the chrominance signal is applied to the cathode instead of the grid of the picture tube. On such receivers, the red, blue, and green gun switches will not cut off the picture tube guns. In these receivers the individual guns can be turned off by turning down the screen (drive) controls. Be sure to follow the manufacturer's instructions.

( ) Attach red, green, and blue leads of the Generator to the red, green, and blue grid leads of the picture tube socket. Be sure the point of each alligator clip pierces the insulation of the lead it is connected to. Attach the black lead to ground.

( ) Turn on the receiver and tune to an unused channel from 2 through 6.

( ) Set the PATTERN switch of the Generator to DOTS.

( ) Turn the Generator on and tune it to the receiver.

( ) Set the Display switch to 3x3.

Keep the color level control at a relatively low level when dot patterns are being used. This will prevent smearing between some of the rows of dots. A low level of brightness will also keep the dots smaller in size, and sharper in detail, making them easier to converge.

( ) Turn off the blue gun by placing the BLUE GUN switch in the SHORT position.

( ) With the blue gun off, adjust the red and green static convergence magnets to converge the dots in the center area of the picture tube screen into a pure yellow.

( ) Turn on the blue gun by placing the BLUE GUN switch in the NORMAL position.

( ) Adjust the blue static magnet and the blue lateral magnet so that the blue converges with the yellow to obtain a white dot in the center portion of the screen.

( ) If a red or green edge appears at one edge of the white dots, turn the blue gun off and touch up the convergence of the red and green dots as necessary.

( ) Turn on the blue gun and recheck the white dots. Retouch as necessary.

NOTE: Some red may show around the edges of the dots. This is due to the red dots being normally slightly larger than the blue and green dots.

Without disturbing the Generator/receiver setup continue to the Purity Adjustments that follow.

PURITY ADJUSTMENTS

The purpose of the purity adjustment is to align the electron beams in order that the red beam strikes only the red phosphor dots, the green beam strikes only the green phosphor dots, and the blue beam strikes only the blue dots as the screen of the picture tube is scanned. This will remove impure color areas from the screen. See Figure 6.

( ) With the Generator connected and tuned to the receiver as at the completion of the Static Convergence Adjustments, place the PATTERN switch of the Generator to PURITY.

( ) Turn the Contrast control on the TV receiver fully counterclockwise.

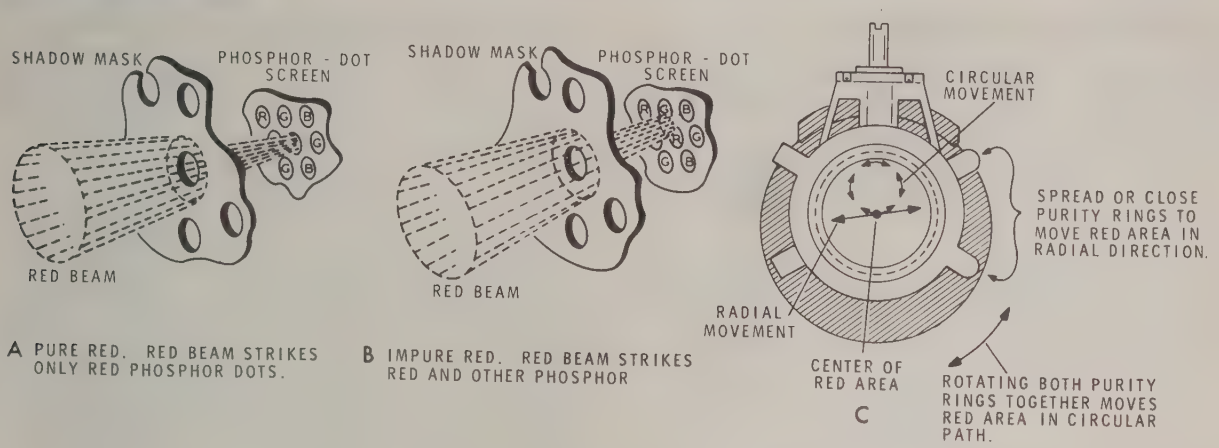

SHADOW MASK
PHOSPHOR - DOT SCREEN
RED BEAM
A PURE RED. RED BEAM STRIKES ONLY RED PHOSPHOR DOTS.
SHADOW MASK
PHOSPHOR - DOT SCREEN
RED BEAM
B IMPURE RED. RED BEAM STRIKES RED AND OTHER PHOSPHOR
CIRCULAR MOVEMENT
SPREAD OR CLOSE PURITY RINGS TO MOVE RED AREA IN RADIAL DIRECTION.
RADIAL MOVEMENT
CENTER OF RED AREA
ROTATING BOTH PURITY RINGS TOGETHER MOVES RED AREA IN CIRCULAR PATH.
C

Figure 6

NOTE: If after performing the next two steps, the picture tube appears all red, the purity does not require adjustment. Therefore, disregard the following steps and proceed to Dynamic Convergence Adjustments.

( ) Turn off the green and blue guns by placing the GREEN and BLUE GUN switches in the SHORT position.

( ) Loosen the deflection yoke and move it straight back as far as it will go in the yoke mount. Use extreme care not to shift the angular position of the yoke.

( ) Adjust the purity rings to produce an approximately uniform red spot in the center portion of the picture tube screen. Do not be concerned with the outside edges of the screen.

( ) When the spot is centered on the screen, slowly move the yoke a small amount forward, toward the face of the tube to make the red area larger. Alternately adjust the yoke and purity rings until the entire screen is filled with a uniform, pure red color.

( ) Set the PATTERN switch of the Generator to HORIZ. LINES to be sure the yoke has not shifted position.

( ) Retighten the deflection yoke.

NOTE: Readjust the red purity if the green and blue purity is not good.

( ) Place the RED GUN switch in the SHORT position and the GREEN GUN switch to NORMAL, then check the purity of the green screen.

( ) Change the BLUE GUN switch to NORMAL and the GREEN GUN switch to SHORT, and check the purity of the blue screen.

( ) Return the RED GUN and GREEN GUN switches to NORMAL.

( ) Set the PATTERN switch of the GENERATOR to DOTS and check the static convergence. Touch up the static convergence after the purity adjustments are completed.

GRAY SCALE ADJUSTMENTS

The purpose of these adjustments is to remove any predominant color shade that might appear in a black and white picture.

( ) Connect the shielded cable from the Generator to the VHF antenna terminals of the receiver.

( ) Turn the receiver to an unused channel from 2 through 6.

( ) Set the PATTERN switch to PURITY and turn on the Generator.

( ) Tune the Generator to the receiver.

( ) Adjust the contrast and color controls on the TV receiver to minimum.

( ) Adjust the brightness control of the TV receiver for a faint raster (faint light on the screen).

( ) Set the KINE bias switch to the minimum brightness position, and the CRT drive controls to minimum. Then set the red, green and blue screen controls to minimum.

NOTE: If any one of the screen controls cannot produce the specified faint color raster, advance the KINE bias switch to its next position. Leave the bias switch in the lowest position that permits proper adjustment of all screen controls.

( ) Advance the red screen control to produce a faint red raster.

( ) Advance the green screen control to produce a faint yellow raster.

( ) Advance the blue screen control to produce a faint white raster.

( ) Set the PATTERN switch of the Generator to GRAY SCALE.

( ) Observe the highlights and lowlights of the pattern. A tint in the highlights can be corrected by adjusting the proper drive controls. A tint in the lowlights can be corrected by adjusting the proper screen controls. The various shaded bars should have a brightness value but no color.

DYNAMIC CONVERGENCE ADJUSTMENTS

The purpose of the dynamic convergence adjustment is to converge the red, green, and blue dots into white dots in the areas away from the center of the screen.

NOTE: On television receivers that have pin cushion adjustments, be sure to check this adjustment before going through Dynamic Convergence. Do not try to obtain perfect convergence at all corners of the screen, since in most cases this cannot be realized, especially in sets without pin cushion adjustments. Careful examination of any color receiver will show slight misconvergences, especially near the corners of the picture. When all dots appear as pure white at a normal viewing distance (at least five feet away), the convergence is considered satisfactory.

A typical convergence board is shown in Figure 7. The areas of the picture tube screen affected by the various dynamic convergence controls are also shown in this figure.

VERTICAL DYNAMIC CONVERGENCE

( ) With the Generator still connected and tuned to the receiver as at the completion of the Purity Adjustments, place the PATTERN switch of the Generator in the DOTS position.

( ) Turn off the blue gun by placing the BLUE GUN switch in the SHORT position.

Refer to Figure 7. Note that the convergence circuit board is divided into four rows of controls and coils. The two rows at the bottom converge the vertical center line in areas 1 and 2 on the picture tube screen. The two rows at the top converge the horizontal center line in areas 3 and 4 of the screen.

NOTE: Only the center vertical row of dots will be adjusted in areas 1 and 2 in the following steps. Since a certain amount of interaction will occur between the controls, it will be necessary to repeat the next two steps several times before the dots become converged in both areas.

( ) Adjust control A, and then control D to move the red and green dots closer together vertically in area 1 and area 2.

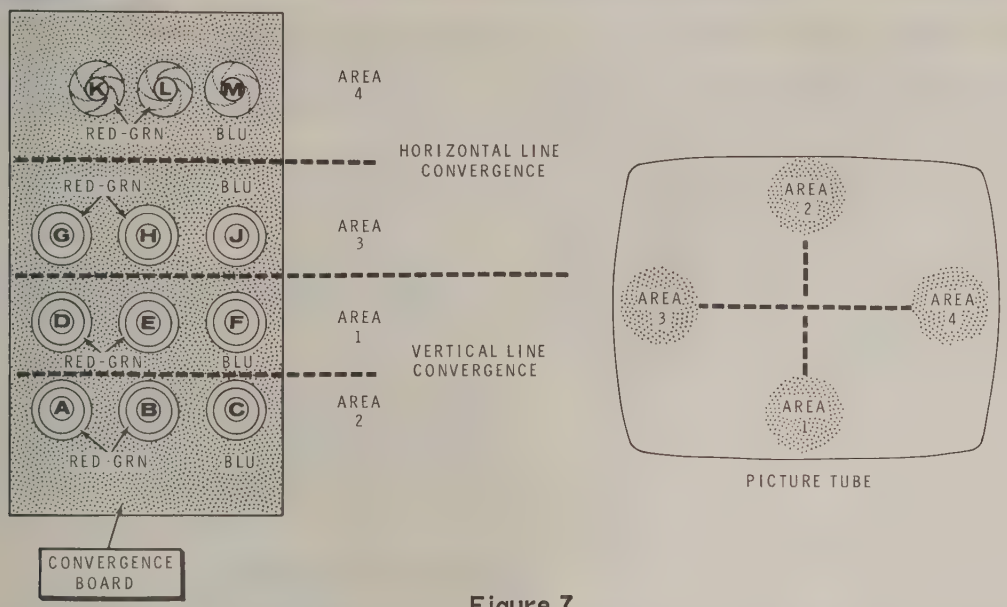


Figure 7

( ) Adjust control B, and then control E to converge the red dots and green dots into yellow dots in area 1 and area 2.

( ) Check all of the dots in the vertical line in areas 1 and 2. Make sure that all red and green dots are merged together to form pure yellow dots. If the dots near the center of the screen are not properly converged, readjust the red and green static convergence magnets, then repeat the previous two steps.

( ) Place the BLUE GUN switch in its NORMAL position.

( ) Merge the blue dots with the yellow dots to make white dots in area 1 and area 2, by adjusting controls C and F.

( ) Check all the dots in the center vertical row to make sure they are all white. If the blue dots at the center of the screen are not properly converged, readjust the blue static convergence magnet and the blue lateral magnet; then repeat the previous step.

This completes convergence of the vertical center row of dots.

HORIZONTAL DYNAMIC CONVERGENCE

( ) Figure 7 shows the area where each horizontal convergence control or coil is most effective. Refer to this Figure to see which dots each control or coil will move, and see which way they will move.

( ) Place the BLUE GUN switch in the SHORT position.

NOTE: To overcome the interaction between the controls, repeat the next two steps as many times as necessary until the dots are merged at both locations. The coil adjustments are not as responsive as the controls adjusted previously. Two or three turns of each coil may be necessary to cause noticeable dot movement.

( ) Adjust controls G and H to converge the red and green dots in area 3 on the picture tube.

( ) Adjust coils K and L to converge the red and green dots in area 4 on the picture tube.

( ) Place the BLUE GUN switch in the NORMAL position.

( ) Merge the blue dots with the yellow dots at areas 3 and 4 by adjusting coil M and control J.

This completes the Convergence Adjustments.

COLOR SYNC CIRCUIT ADJUSTMENTS

To correctly display color on the screen, the color detector circuits of the receiver must be synchronized (the same frequency and phase angle) with the transmitted color subcarrier. For this reason a 3.58 MHz color burst signal is included in the transmitted TV signal as a reference. The 3.58 MHz oscillator in the color - sync section of the receiver generates a signal which is compared with the transmitted reference burst signal, and is automatically locked in with the burst signal.

Touch-Up Adjustment

The following procedure can be used for a touch-up adjustment of the color sync circuit.

( ) Attach the RF output leads of the Generator to the VHF antenna terminals of the receiver.

( ) Turn on the receiver and tune to an unused channel from 2 through 6.

( ) Turn the PATTERN switch of the Generator to COLOR BAR.

( ) Turn on the Generator and tune it to the receiver.

( ) Adjust the receiver to produce a normal pattern. (Refer to pattern #6 on Figure 2A fold-out from Page 37.)

( ) Adjust the RF LEVEL control of the Generator to produce a normal intensity pattern.

( ) Place the tint control of the receiver in its mid-range position.

( ) Disable the reactance control tube stage. NOTE: Most receivers have a service test point near the reactance tube which is accessible from the top of the chassis for this purpose.

( ) Adjust the reactance coil for a zero beat in the color bar pattern on the screen. Zero beat occurs when the color bars are straight up and down and the colors drift very slowly.

( ) Reactivate the reactance control tube. The color bar pattern should lock in immediately.

( ) Slowly rotate the tint control through its entire range. The color bars should stay locked in at all settings of the tint control.

NOTE: If the color bars do not stay locked in at all settings of the tint control, or if the color disappears at some settings, the complete color sync section adjustment should be made.

Complete Adjustment

The following procedure can be used for a complete adjustment of the color sync circuit.

( ) With the Generator connected and tuned to the receiver as at the completion of the touch-up adjustment, return the tint control of the receiver to its mid-range position.

( ) Attach the DC probe of an 11 megohm input voltmeter to the plate of the burst phase detector. In a dual diode arrangement, the other plate and cathode are tied together and connected to ground.

( ) Set the voltmeter to the -15 VDC range and connect its common lead to ground.

( ) Disable the burst amplifier stage to prevent the burst signal from causing an erroneous reading.

( ) Adjust the oscillator transformer for a maximum negative indication on the meter. (In the range of -5 volts.)

( ) Reactivate the burst amplifier stage.

( ) Adjust the burst transformer for a maximum indication on the meter.

( ) Disable the reactance control tube stage.

( ) Adjust the reactance coil for a zero beat.

( ) Reactivate the reactance control tube stage. The color bar pattern should lock in immediately.

( ) Place the DISPLAY switch in the 9x9 position and check the range of the tint control. The tint control should be able to move the entire color bar pattern by one bar in either direction.

( ) Remove the Generator output leads from the receiver.

( ) Tune the receiver to a station that is transmitting a color program.

( ) Rotate the tint control through its entire range. If the color does not lock in at all settings, troubleshoot the color sync stages of the receiver.

COLOR DEMODULATOR PHASE ADJUSTMENT

The color demodulator circuits of the receiver separates the chrominance information into the R-Y and B-Y signals. These two color signals are then combined and amplified to provide the color signals to the grids of the red, green, and blue guns. The 3.58 MHz oscillator provides the reference to the demodulators for correct color signals.

The following procedure can be used for adjusting the phase of the color demodulator circuits. The Pattern can be displayed in 9x9, or 3x3 as you prefer. For convenience, the following steps refer only to the 3x3 display pattern.

( ) Attach the RF output leads of the Generator to the antenna terminals of the receiver.

( ) Turn on the receiver and tune to an unused channel from 2 through 6.

( ) Turn the PATTERN switch of the Generator to COLOR BAR.

( ) Turn on the Generator and tune it to the receiver.

( ) Adjust the receiver brightness and contrast controls for a good contrast pattern.

( ) Set the receiver color intensity control to about 1/4 of its rotation.

( ) Set the color tint control to its mid-range.

( ) Connect the vertical input of a wideband oscilloscope to the grid of the blue picture tube gun. The front panel grid jacks can be used for oscilloscope connections.

Refer to Figure 8 for the following steps.

( ) Adjust the burst phase transformer so that the second bar is at maximum and the first and third bar is passing through zero.

( ) Move the oscilloscope connection to the grid of the red picture tube gun. The first bar should be at maximum when the second bar is passing through zero and the third bar is at maximum negative.

( ) Move the oscilloscope connection to the grid of the green picture tube gun. The third bar should be at maximum when the first bar is maximum negative and the second bar is passing through zero.

( ) Turn the Generator and TV receiver power switches to OFF.

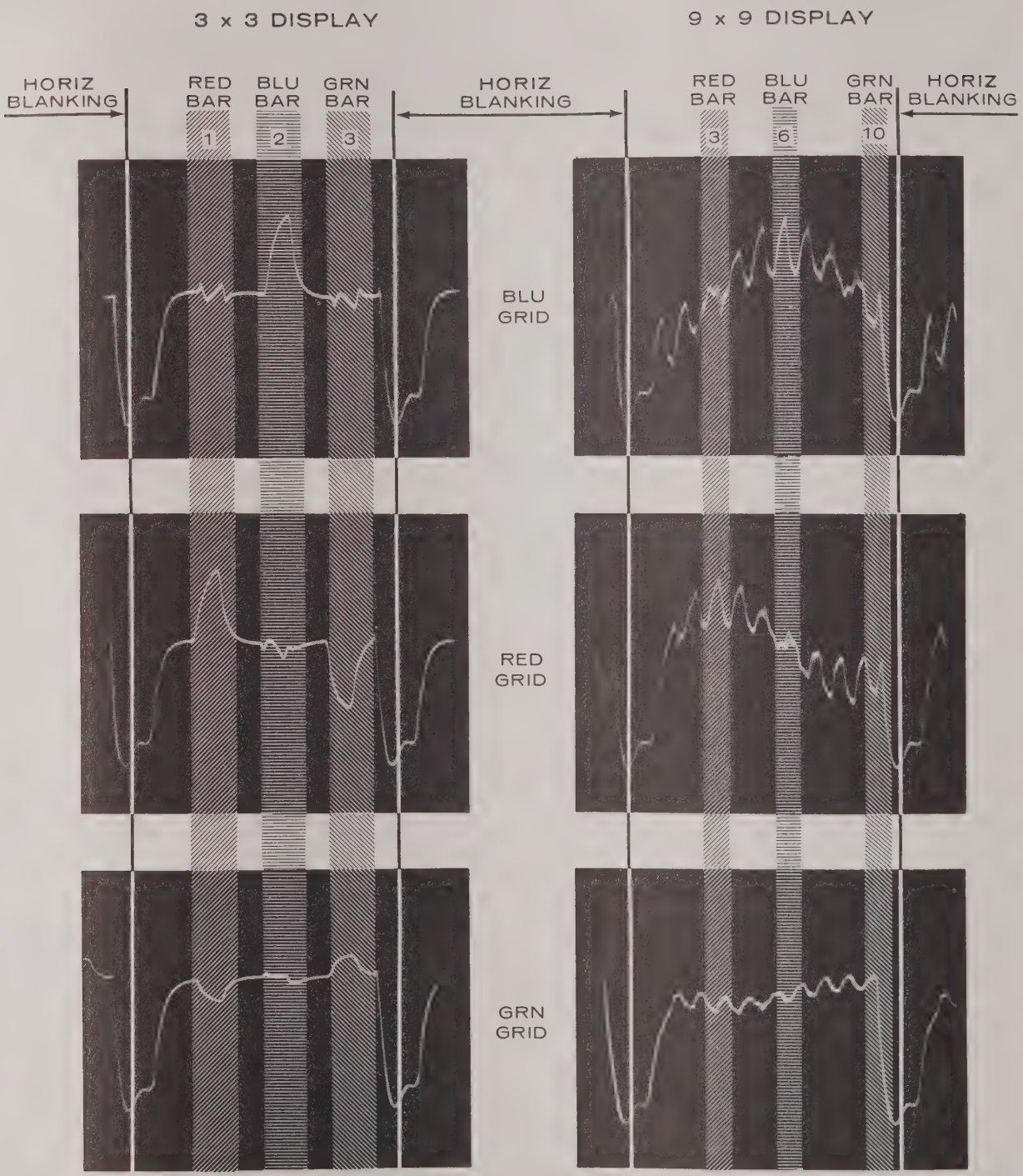
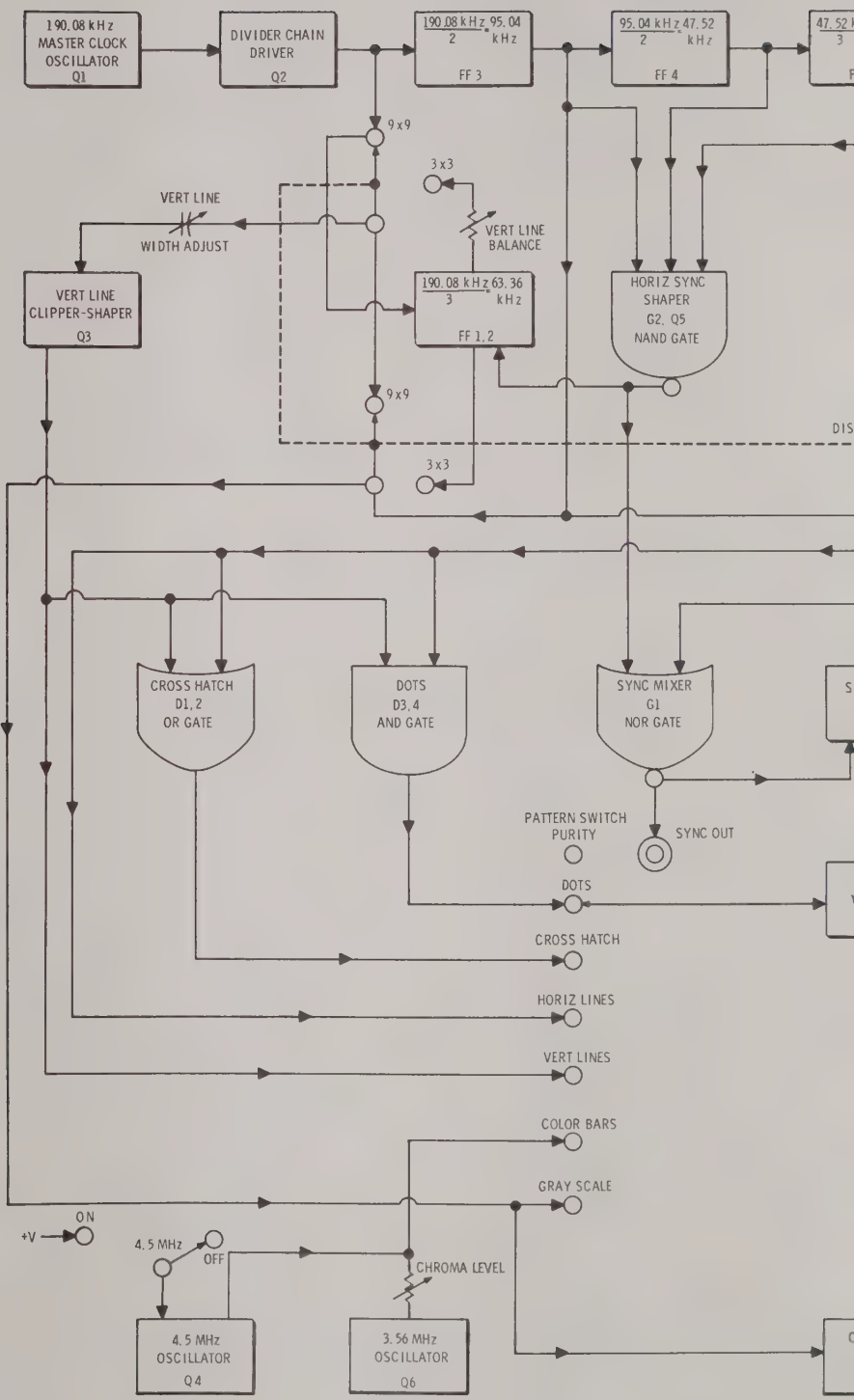
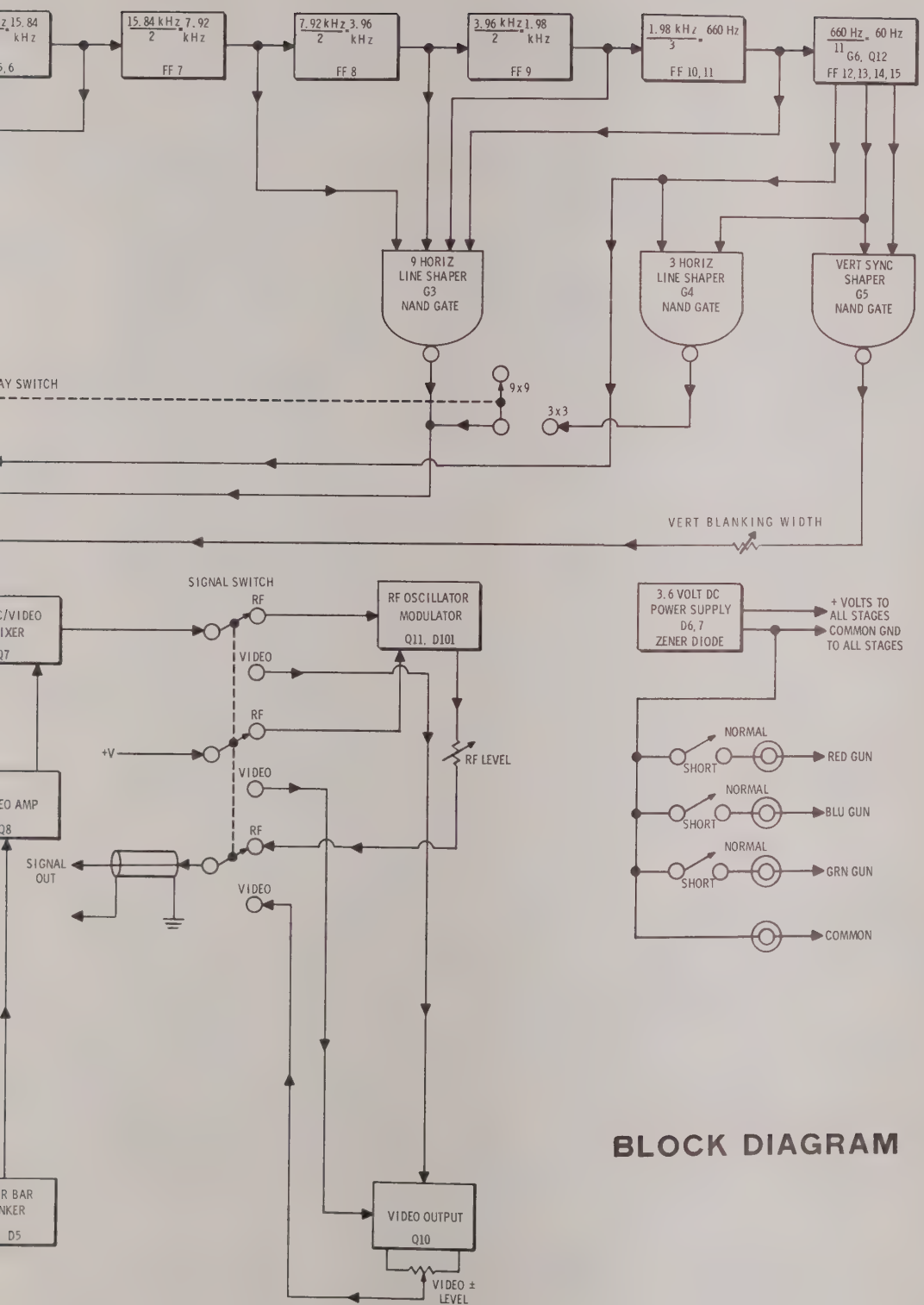

3 x 3 DISPLAY
9 x 9 DISPLAY
HORIZ BLANKING
RED BAR
BLU BAR
GRN BAR
HORIZ BLANKING
1
2
3
RED BAR
BLU BAR
GRN BAR
HORIZ BLANKING
3
6
10
BLU GRID
RED GRID
GRN GRID

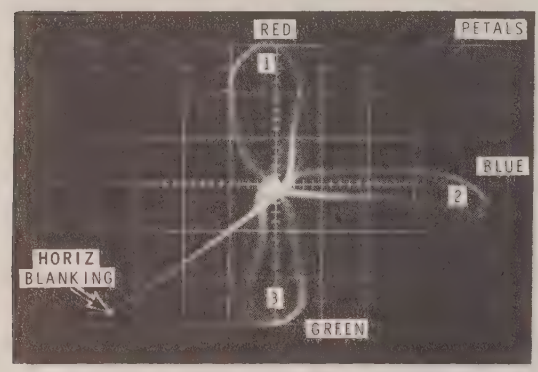
FIGURE 8


190.08 kHz MASTER CLOCK OSCILLATOR Q1
DIVIDER CHAIN DRIVER Q2
190.08 kHz / 2 — 95.04 kHz FF 3
95.04 kHz / 2 — 47.52 kHz FF 4
9 x 9
3 x 3
VERT LINE
WIDTH ADJUST
VERT LINE BALANCE
VERT LINE CLIPPER-SHAPER Q3
190.08 kHz / 3 — 63.36 kHz FF 1, 2
HORIZ SYNC SHAPER G2, Q5 NAND GATE
CROSS HATCH D1, 2 OR GATE
DOTS D3, 4 AND GATE
SYNC MIXER G1 NOR GATE
PATTERN SWITCH PURITY
SYNC OUT
DOTS
CROSS HATCH
HORIZ LINES
VERT LINES
COLOR BARS
GRAY SCALE
+V
ON
OFF
4.5 MHz
CHROMA LEVEL
4.5 MHz OSCILLATOR Q4
3.56 MHz OSCILLATOR Q6

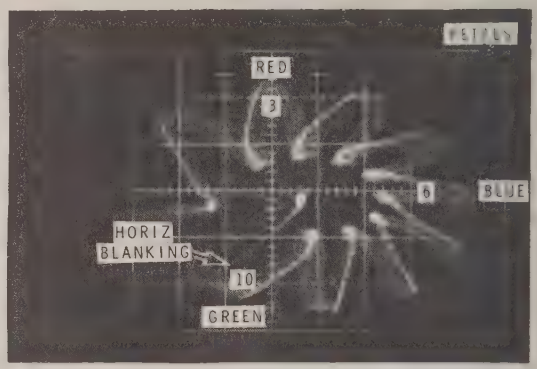


BLOCK DIAGRAM

3X3



9X9



These photographs are typical of the Heath color receivers with a demodulation angle of approximately 104 degrees ±10.

Figure 9

VECTOR SCOPE DISPLAY

Figure 9 shows a 3x3 and 9x9 vector scope pattern. This display can be produced on any oscilloscope and may be used to check and adjust the following color circuits: The 3.58 MHz oscillator plate coil, reactance coil, phase detector transformer, demodulation angle, bandpass amplifier coil, and the color take-off plate coil. Use the following instructions to obtain the vector display. The receiver manufacturer's alignment instructions should be followed to properly check and align the color circuits, since these adjustments may vary from one TV manufacturer to another.

NOTE: When you use this display, be sure to check the demodulation angle that is prescribed for the TV receiver you are adjusting.

( ) Connect the red and blue leads of the generator to the respective red and blue grid leads of the picture tube socket. Connect the black lead to ground.

( ) Connect the vertical input of the oscilloscope to the Generator RED GRID jack.

( ) Connect the horizontal input of the oscilloscope to the Generator BLUE GRID jack.

( ) Connect the oscilloscope ground to the Generator GROUND jack.

( ) Set the PATTERN switch to COLOR BARS.

( ) Pull the Generator power switch to ON.

( ) Turn on the oscilloscope power.

( ) Turn on the television receiver.

NOTE: The display on the oscilloscope may be reversed from that shown in Figure 9. This is due to the internal wiring of the oscilloscope. If this is the case, be sure to count the bars (petals) counterclockwise instead of clockwise.

( ) Refer to the receiver manufacturer's alignment instructions and adjust the receiver.

( ) Turn off the Generator.

( ) Turn off the oscilloscope and TV receiver.

( ) Disconnect the Generator from the TV receiver and the oscilloscope.

PRINCIPLES OF COLOR TV

A knowledge of basic color television theory will help you to make the best use of your Color Bar And Dot Generator. This section of the Manual is intended to supply, or refresh, your understanding of the principles of color TV.

The Heathkit Color Bar And Dot Generator provides stable test signals for servicing black and white as well as color receivers. All output signals from the Generator may be used for both types of receivers; however, the color bar patterns will appear as black and white bars on a black and white receiver.

Except for the additional circuitry required for color reception, the two types of receivers are basically the same. Therefore, your understanding of black and white receiver servicing can be readily applied to color servicing. To fully utilize the many features of this Generator, a knowledge of the circuits and terms peculiar to color receivers is also desirable. Some basic discussions of these circuits and terms are provided in this section. Further information may often be obtained from local educational institutions who can suggest books or courses covering these subjects.

LIGHT

The visible portion of light is located between infrared and ultraviolet in the electromagnetic spectrum. The visible light spectrum may be broken into the following sequence of colors: red, orange, yellow, green, blue, and violet. All other colors are a combination (in various proportions) of two or more of these colors. The combination of all of the colors in the proper proportion will produce white light. It has been established experimentally that the combination of only three colors (red, green, and blue) in the proper proportion will also produce white light. Combining these three "additive colors" in different combinations and proportions will produce a variety of other colors. Color television is based on this combining characteristic of the three additive colors.

Light has three distinct characteristics. The amount of energy reaching the eye is called brightness. The wavelength of the energy within the light spectrum is called hue or color. The quantity or pureness of the hue is called saturation. Colored light has all three characteristics: brightness, hue, and saturation. White light has only brightness.

COLOR TV SIGNAL

In order to faithfully reproduce a color picture, the color signal must contain information about all three light characteristics. The luminance signal (commonly referred to as the "Y" signal) contains all the information pertaining to the brightness of the picture. The chrominance signal contains all information pertaining to hue and saturation of the signal.

The color television camera is composed of three separate image tubes. The red tube sees only red and red components of the other colors. In the same way, the green tube sees only green, and the blue tube sees only blue. The relative intensity of the colors is also picked up by the camera. The output signal from the camera thus contains both the necessary luminance and chrominance information.

TELEVISION PICTURE TUBES

The black and white picture tube displays only various shades of white light. The hue and saturation of the three basic colors are fixed by the phosphor screen of the tube. Brightness is controlled by varying the amount of electrons that strike the screen. Thus, only one electron gun, producing one electron beam, is required in a black and white picture tube.

The color television picture tube displays color as well as white light at various levels of brightness, hue and saturation. A separate electron gun is required for each of the three primary colors. White light is produced by mixing the primary colors in the proper proportion. As in the black and white tube, the electron beam controls only brightness. The color is produced on the phosphor screen of the picture tube.

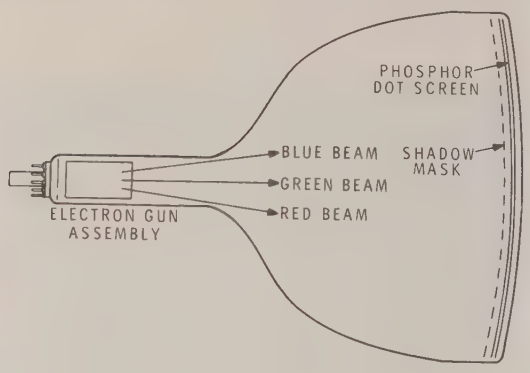


Figure 10

The three main parts of the color picture tube are the phosphor dot screen, shadow mask, and three electron gun assemblies. See Figure 10. The phosphor screen has three different types of phosphors placed in minute triangular dot patterns called triads. The dots are placed very close together but do not touch each other. See Figure 11. Each dot in each triad glows a different primary color when struck by an electron beam.

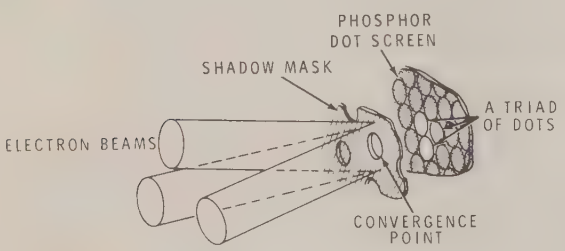


Figure 11

The human eye cannot distinguish the separate dots in a triad at normal viewing distance. The eye blends the three light emissions to give the appearance of a single color. For example, when the light outputs of a triad of dots are in the proper proportion to produce white light, each dot glows with its respective color, but the eye blends them together so that the screen will appear to be white. By controlling the saturation of the dots, it is possible to produce a variety of colors.

Each electron beam must be made to strike its respective dot in a triad as the line is scanned. A shadow mask is placed between the electron guns and the screen for this purpose. The shadow mask is a thin sheet of metal that has been etched with a series of small holes. These holes are positioned so that each one is aligned with a triad of dots. The electron beams from the three guns must converge at a hole in the shadow mask so that each beam strikes only its respective color dot as the beams are scanned across the screen.

By varying the intensity of all three beams simultaneously, the brightness of the triad can be controlled. In addition, the intensity of each electron beam can be individually controlled to emphasize one or more dots and thus produce all desired colors.

The red, green, and blue electron guns are equally spaced 120 degrees apart around the center axis of the gun assembly. The three guns are identical; and each contains a filament, cathode, #1 grid (control), #2 grid (accelerating anode), #3 grid (focus electrode) and a #4 grid. The #4 grid is a high voltage anode which is connected to the shadow mask and the inside coating of the tube. See Figure 12.

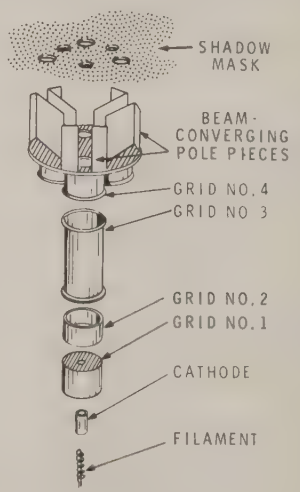


Figure 12

The brightness of the picture is determined by the luminance component of the color TV signal; color is determined by the chrominance component. The luminance component of the signal is applied to the picture tube cathodes and furnishes a controlling voltage to all three beams

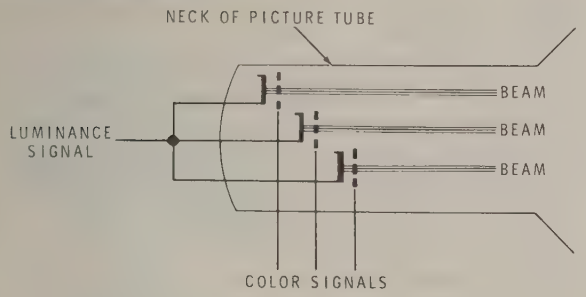


Figure 13

simultaneously, thus controlling illumination of the screen. The chrominance component of the signal is applied to the control grids of the picture tube to produce the desired color on the screen. See Figure 13.

The absence of a chrominance signal produces a black and white picture, because the controlling voltages for all three beams are provided in the proper proportions by the luminance signal. With no color signal applied to the control grids, the beams will be controlled by the luminance signal only, making a black and white picture. Black and white TV sets use only the luminance signal which is the sum of the brightness contained in all three color signals. The color transmitting system is therefore compatible with either black and white or color TV sets.

The physical relationship of the electron beams, shadow mask, and phosphor screen is critical. Very close tolerances are used during manufacture of the tube, but some variations still exist. To compensate for these variations, static magnetic beam controls are mounted outside the neck of the picture tube. See Figure 14. The purpose of these magnetic beam controls is to regulate purity.

PURITY

The uniformity of the brightness and hue of each of the three primary additive colors is called Purity. If two of the electron guns are biased off as the screen is scanned, the remaining gun will produce a pure red, green, or

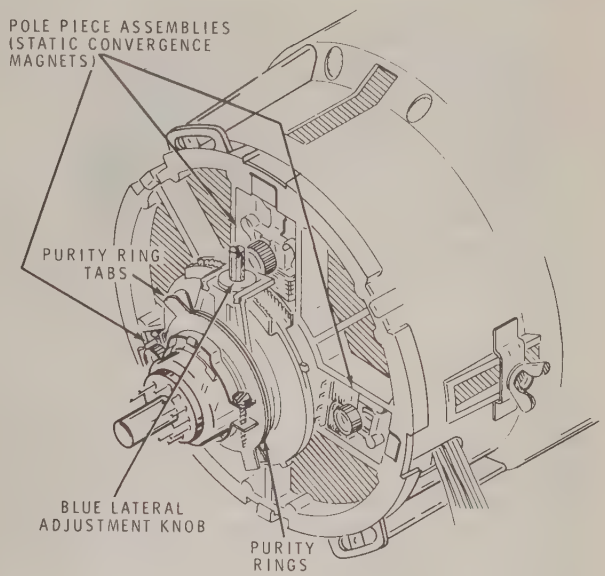


Figure 14

blue raster as the electron beam strikes only its own color phosphor dots. The term purity describes the color quality of these individual rasters. For example, when the red raster is a uniform red, with no contamination from blue or green, the red field of the picture tube is properly adjusted.

The purity magnet and the deflection yoke are used to properly adjust the picture tube for purity.

The purity magnet consists of two magnetic rings. Each ring has a north and south pole and can be individually rotated 360 degrees. With unlike poles adjacent to each other, no appreciable magnetic field exists. When one ring is rotated, the magnetic field increases in strength and becomes strongest when like poles are adjacent to each other.

The field produced by the purity magnets is uniform and exerts an equal force on all three beams. Depending on the relative position of both rings, the force exerted by the field can position the three beams vertically, horizontally or anywhere between the two axes.

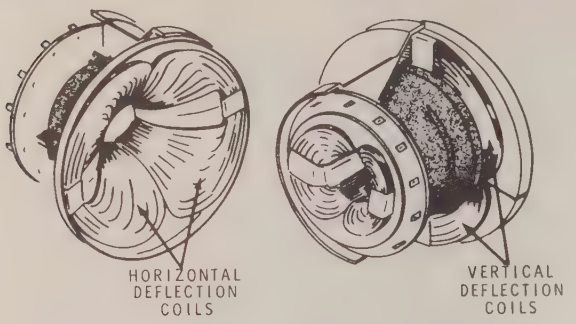


Figure 15

The purity magnets affect purity adjustment in the center of the screen only. The position of the deflection yoke is used to achieve purity around the edges of the screen. The deflection yoke consists of two different pairs of coils. These coils are positioned perpendicular to each other and are shaped to fit over the neck of the tube. See Figure 15. When current is applied through the deflection yoke coils, a magnetic field is formed between them. This field varies in strength and direction in proportion to the current applied to the coils. The field exerts an equal force on all three beams and deflects them vertically and horizontally across the screen.

The physical position of the yoke on the neck of the tube is critical. If the yoke is positioned improperly, the angle of deflection will be changed and the beams may strike the wrong color dots which distorts color purity. The error will be especially noticeable around the outer edges of the screen.

CONVERGENCE

All three electron beams must be aimed at the same hole in the shadow mask at the same instant for the beams to converge on the proper triad of dots. The travel of the individual beams can be corrected by static and dynamic magnetic fields to accomplish convergence.

STATIC CONVERGENCE

A beam positioning pole piece assembly is mounted over each gun. Each magnet provides a field that will move the beam of its gun toward or away from the center axis of the picture tube. The magnets are adjustable. Static magnetic beam controls are mounted outside the neck of the tube to control the amount of deflection. The lateral correction magnet provides a magnetic field to move the blue beam in a horizontal direction.

DYNAMIC CONVERGENCE

The static convergence magnets are effective in the center of the screen but cannot compensate for the curvature of the screen. To accurately control convergence at the edges of the screen, a vertical and horizontal coil are mounted over a horseshoe shaped magnet located in the pole piece assemblies over each gun. An AC signal, in step with the horizontal and vertical sweep signals, is applied to each coil to produce a magnetic field. This field corrects the direction of the beams before the field of the deflection yoke acts upon them.

IN CASE OF DIFFICULTY

This section of the Manual is divided into four parts. The first part, titled General Troubleshooting Information, describes what to do about any difficulties that may occur right after the kit is assembled.

The second part, titled Finding The Area Of Trouble describes a method for locating trouble in the divider chain, IC's or gates.

The third part, a Troubleshooting Chart, is provided to assist in servicing if the General information does not clear up the problem, or if difficulties occur after the instrument has been in operation for some time. This Chart lists a number of possible difficulties that could arise, and lists several possible causes.

Before starting any troubleshooting procedure, try to narrow the problem down to a specific area by trying the various functions of the instrument.

GENERAL TROUBLESHOOTING INFORMATION

The following paragraphs deal with the types of difficulties that may show up right after a kit is

assembled. These difficulties are most likely to be caused by assembly errors or faulty soldering. These checks will help you locate any error of this type that might have been made.

1. Recheck the wiring. Trace each lead in colored pencil on the Pictorial as it is checked. It is frequently helpful to have a friend check your work. Someone who is not familiar with the unit may notice something consistently overlooked by the constructor.

2. About 90% of the kits that are returned for repair do not function properly due to poor connections and soldering. Therefore, many troubles can be eliminated by reheating all connections to make sure that they are soldered as described in the Soldering section of the Kit Builders Guide.

3. Check to be sure that all transistors are in their proper locations. Make sure each transistor lead is connected to the proper point.

4. Check that each of the IC pins are properly installed in their sockets, and not bent under the IC. Also be sure the IC's are installed in their correct sockets.

5. Check the values of the parts. Be sure that the proper part has been wired into the circuit as shown in the pictorial diagrams, and called out in the wiring instructions.

6. Check for bits of solder, wire ends or other foreign matter which may be lodged in the wiring. Check for solder bridges between circuit board foils. Compare your foil pattern against the X-Ray Views (fold-out from Page 65). Be particularly watchful of the foil area around the IC sockets for solder bridges.

7. If after careful checks, the trouble is still not located and a voltmeter is available, check the voltage readings against those shown on the Schematic Diagram. NOTE: All voltage readings were taken with an 11 megohm input voltmeter. Voltages may vary as much as 20%.

8. A review of the Circuit Description may also help you determine where to look for the trouble.

NOTE: In an extreme case where you are unable to resolve a difficulty, refer to the "Customer Service" information inside the rear cover of the Manual. Your Warranty is located inside the front cover of the Manual.

FINDING THE AREA OF TROUBLE

Refer to the Block Diagram (fold-out from Page 46) and the Schematic (fold-out from Page 69) when making the following checks. The Block Diagram shows the signal path and the Schematic shows pin numbers of the IC inputs and outputs.

Divider Chain

The complete divider chain can be checked by connecting an oscilloscope to the Generator SYNC jack. There should be a 15.840 kHz signal and a 60 Hz signal present at this jack.

If 15.840 kHz is not present this would indicate something wrong with Q1, Q2, FF3 through FF6, G2, Q5, or G1.

If 15.840 kHz is present but the 60 Hz signal is not, this would indicate something wrong with FF7 through FF15, G6, Q12, G5, or G1.

IC's

To check an IC, connect the oscilloscope to the trigger input (T) of the IC and check for the presence of a signal. If no signal is present, check the Q and $\overline{Q}$ outputs of the previous IC. An IC that has no output but does have an input would indicate that the IC is faulty.

To check the IC, interchange it with a known good IC from a later stage.

Gates

A signal is required at all of the inputs of gates G2, G3, G4, G5, and G6 to receive a signal at the output. A signal at either input of gate G1 should produce a signal at the output. If there is no signal at the input of a gate, it would indicate that there is a break in the signal path between the divider chain output and the gate input. This could be caused by an intermittent connection or a bent IC pin.

A gate can be checked with an oscilloscope. If there is a signal present at each of the correct inputs, but no signal at the output, it would indicate a faulty gate or a shorted output. To check the gate, interchange it with a known good IC gate.

TROUBLESHOOTING CHART

DIFFICULTY	POSSIBLE CAUSE
Tunes some but not all channels 2 through 6.	1. C108 misadjusted.
Weak or no RF signal output.	1. RF Level control set too low. 2. Transistor Q11 or associated components.
RF but no video output.	1. Pattern switch in Purity position. 2. Pattern switch incorrectly wired. 3. Diode D5. 4. Transistor Q7, Q8, or Q9, Q10.
Video but no sync.	1. Gate G1. 2. Transistor Q7. 3. Integrated circuits or solder short on circuit board.
No color bars.	1. Chroma Level control turned counter-clockwise. 2. Capacitor C16. 3. Transistor Q6. 4. 3.56 MHz crystal.
Color rainbow but no color bars.	1. Diode D5. 2. Transistor Q9. 3. Pattern switch incorrectly wired. 4. No keying pulse to Q9.
No vertical bars, dots, or crosshatch.	1. Transistor Q3. 2. Capacitor C5 misadjusted.
No horizontal lines, dots or crosshatch.	1. NAND gate G3 or G4.
No 4.5 MHz signal.	1. Transistor Q4 shorted. 2. 4.5 MHz crystal.
Guns will not short.	1. Ground wire on 4-wire cable not connected. 2. Clip not touching control grid wires. 3. Clip on wrong control grid wire.

SPECIFICATIONS

PATTERNS

Purity	Produces a snow-free raster for purity adjustments.
Dots*	9x9 produces a display of 110 small dots. 3x3 produces a display of nine dots for convergence adjustments.
Crosshatch*	9x9 produces a display of 11 vertical and 10 horizontal lines. 3x3 produces a display of three vertical and three horizontal lines for convergence and linearity adjustments.
Horizontal Lines*	9x9 produces a display of 10 horizontal lines. 3x3 produces a display of three horizontal lines for vertical linearity and pin-cushion adjustments.
Vertical Lines*	9x9 produces 11 vertical lines. 3x3 produces a display of three vertical lines for horizontal linearity and convergence adjustments.
Color Bars*	9x9 produces a display of ten standard color bars. 3x3 produces a display of three standard color bars for demodulator phase adjustment and color circuit servicing.
Gray Scale	Provides a wide bar crosshatch pattern with six shades of brightness for color gun level adjustments.

OUTPUT SIGNALS

Video	Greater than ±1 volt peak-to-peak composite signal for composite signal injection beyond the video detector.
RF	Variable to 50,000 μV output, channels 2 through 6, for composite signal injection into the receiver antenna input terminals.
Sync	Greater than 3.5 volts peak-to-peak signal for servicing sync circuits without video, or sets having separate video and sync demodulators.
Control Grids (3)	Individual red, blue, and green control grid signals for viewing chroma signal and demodulator phase adjustments.

*The number of dots, lines, and bars indicated for 9x9 display are the number displayed if the receiver under test has no overscan.

POWER SUPPLY

Type.	Transformer operated, full-wave, regulated.
Input.	105-125 or 210-250 VAC, 50/60 Hz.
Output.	3.6 VDC, 500 mA, zener diode regulated.
Cabinet Dimensions. . .(overall).	13-1/2" wide x 5-1/4" high x 8" deep.
Net Weight.	6-1/2 lbs.

The Heath Company reserves the right to discontinue products and to change specifications at any time without incurring any obligation to incorporate features in products previously sold.

THEORY OF OPERATION

This part of the Manual is divided into four parts. The first part will describe the function of various stages in the Generator. It will briefly outline the production of each pattern that is selected by the Pattern switch. The second part will explain flip-flops. Gates will be explained in the third part, and the fourth part will explain composite signals. Refer to the Block Diagram (fold-out from Page 46) while you read this Theory Of Operation.

CIRCUIT OPERATION

The Heathkit Model IG-28 Color Bar And Dot Generator uses combinations of logic circuits to provide the several output patterns. A stable sine-wave signal is generated by a master clock oscillator. This signal is shaped by succeeding stages and proceeds to a divider chain that consists of a series of flip-flop multivibrator circuits. The flip-flops divide the frequency of the master clock signal. At various points in the divider chain, signals of desired frequency are picked off and applied to other logic circuits consisting of AND, NAND, NOR, or OR gates. These circuits, in turn combine the proper signals to produce the desired output patterns.

MASTER CLOCK AND DIVIDER CHAIN

The master clock oscillator generates the primary signal from which all other signals in the timing circuit are obtained. To provide accurate timing signals, the output of the master clock must be very stable. This is accomplished by the use of a crystal controlled Pierce oscillator, which generates a 190.08 kHz signal.

The divider chain driver circuit shapes the 190.08 kHz sine-wave signal into a square-wave signal. This signal is then divided to provide the needed signals to the gate circuits and output switching circuits.

PATTERN CIRCUITS

Signals from various gate circuits, driver and shaper circuits, and crystal controlled oscillators are coupled to the Pattern selector switch. Each position of the Pattern switch selects the signal of the proper frequency and shape to produce the pattern desired.

VERTICAL LINES. The output signal of the master clock and divider chain driver passes through the clipper-shaper stage which differentiates the waveform. This results in a pulse which shows up as a narrow vertical line on the TV screen. This pulse is combined with the sync signal in the sync/video circuit. The combination results in the required number of pulses per horizontal sweep duration; these pulses, in turn, produce the desired number of vertical lines.

HORIZONTAL LINES. The output signal from the divider chain is fed to a NAND gate. This results in a pulse which produces a narrow horizontal line on the TV screen. This pulse signal is combined with the sync signal in the sync video circuit. The combination results in the required number of pulses per vertical sweep duration.

CROSSHATCH. The horizontal line and vertical line signals are combined in an OR gate. Both the vertical and horizontal signals from the output of the OR gate produce the vertical and horizontal lines on the screen in a crosshatch pattern.

DOTS. An AND gate combines the vertical and horizontal signals to produce a dot pattern. Since both signals must be present to produce an output, this condition exists only when the vertical and horizontal lines cross. Thus, horizontal and vertical rows of dots are produced.

GRAY SCALE. The gray scale pattern is produced by combining pulses to form the vertical and horizontal bars in a wide bar crosshatch pattern. The half frequency in each direction will superimpose every other bar to display a change in shade.

COLOR BAR. A color signal is required to trigger and synchronize the color oscillator in a television receiver. This color signal is produced by an oscillator circuit in the Generator which is adjusted to one horizontal line frequency below the color oscillator of the receiver. Thus, the two signals are in phase once during each horizontal blanking pulse, but are out of phase during each horizontal scanning line. See Figure 16. This slow change in phase difference produces an even blending rainbow of colors on the television screen. The rainbow is divided into color bars as the color bar blanker is keyed on and off. The eleventh and twelfth bars are blanked out by the horizontal blanking pulse.

PURITY. Only the composite vertical and horizontal sync signal is required to produce the clear raster needed to make purity adjustments in a receiver. Therefore, none of the pattern producing signals are coupled into the video amplifier circuit. Three color gun-killer switches are provided to bias off the grids of each gun in the picture tube so that the purity of each color can be checked and adjusted.

3x3 or 9x9 Display

The 63.36 kHz signal from FF1, FF2 and the 240 Hz signal from G4 are combined to produce the 3x3 display signal. The 190.08 kHz signal from Q2 and the 660 Hz signal from FF11 are combined to produce the 9x9 display signal.

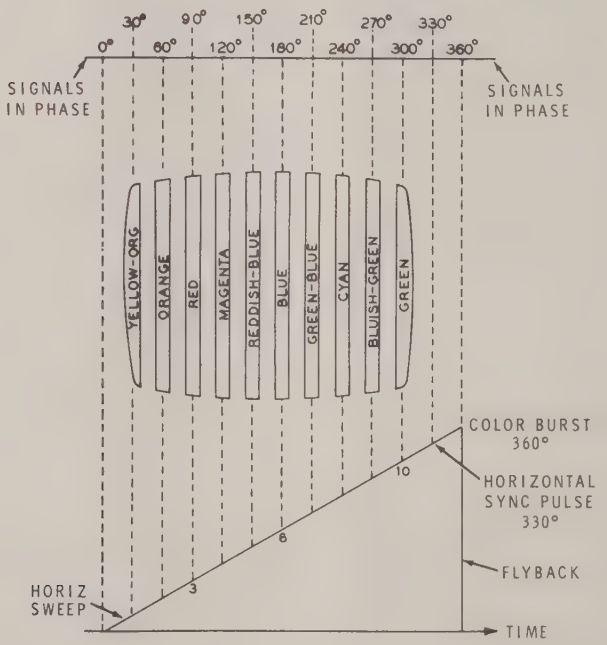


Figure 16

4.5 MHz OSCILLATOR

During color presentation, the sound carrier oscillator signal in the Generator will beat with the color carrier signal in the TV receiver and appear as a herringbone pattern in the color bars. When the receiver tuner is properly adjusted, the IF sound trap will attenuate the herringbone. This provides an accurate means of tuning the receiver or adjusting the IF sound trap.

Signal Output Circuits

The combined vertical and horizontal sync signals and the pattern signal from the video amplifier are combined in the sync-video stages to provide the composite video signal. This composite signal is then coupled to either the video output stage or to the RF oscillator stage, depending upon the position of the Signal switch.

The video output stage supplies the composite video signal for coupling directly into the video circuits of a television receiver. The RF oscillator circuit produces an RF carrier that is tunable through TV channels 2 through 6. The carrier is modulated by the composite video signal and can be coupled to the antenna input terminals of the receiver.

FLIP-FLOPS

The bi-stable multivibrator, or flip-flop as it is generally called, is basically much like a two-position switch. Flip-flops come in many configurations and with several special features. A popular version with great versatility is the "J-K flip-flop", used in this instrument. All flip-flops have two outputs which are indicated by "Q" and "$\bar{Q}$" (not Q). The output level of Q determines the state of the flip-flop.

The J-K flip-flop has three input terminals: set (S), clear (C), and trigger (T). These can be used in such a manner that a pulse applied to the trigger input will or will not switch the output, depending on the "On" conditions at the set and clear terminals. In addition, a preset (P) terminal provides a way to return the flip-flop to a particular state, independently of the trigger input.

With both set and clear grounded, the output becomes "On" once each time two pulses have been applied to the trigger input. This is a divide-by-two action. Note that this action is independent of frequency as long as it does not exceed the switching speed of the flip-flop.

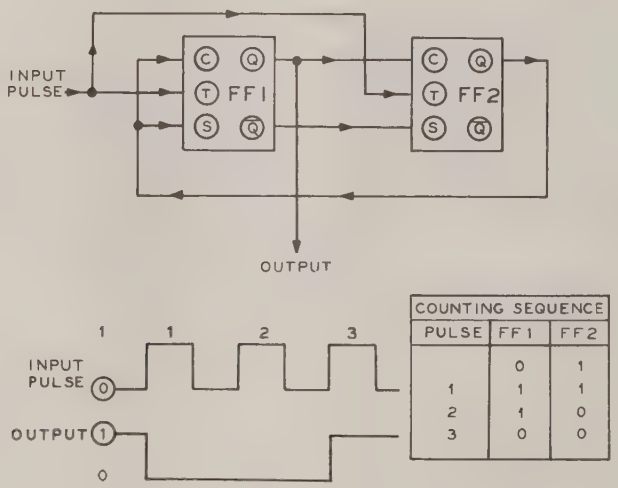
Divide By Three

Figure 17 shows how flip-flops FF1-FF2 are connected to divide-by-three, and the input and output waveform relationships. Assume that the "Q" output of flip-flop FF1 is at a "0" level and the "Q" output of flip-flop FF2 is at a "0" level. The first trigger pulse will cause both flip-flops to change state. This will place the set (S) and clear (C) inputs of flip-flop FF1 at a "1" level, the set input of flip-flop FF2 at a "1" level, and the clear input of flip-flop FF2 at the "1" level.

The second trigger pulse will cause flip-flop FF2 to change state. Flip-flop FF1 was prevented from switching by the "1" level at its set and clear inputs.

NOTE: The trigger pulse appears at the trigger (T) inputs of both flip-flops simultaneously. By the time flip-flop FF2 changes state, the pulse no longer affects flip-flop FF1.

The third trigger pulse will cause flip-flop FF1 to change state but flip-flop FF2 will remain the same. The reason for this is the "0" level appearing at the "Q" output of FF2 already matches the "0" level (prior to flip-flop FF1 switching) at the set input. This relationship is shown in the counting sequence table in Figure 17.



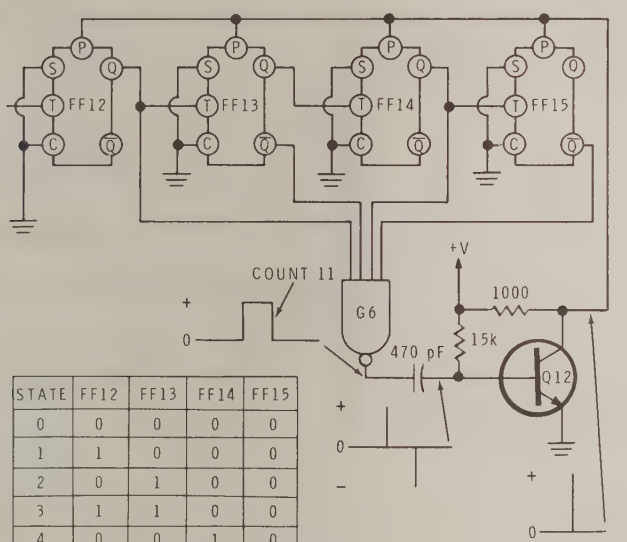
COUNTING SEQUENCE		
PULSE	FF1	FF2
	0	1
1	1	1
2	1	0
3	0	0

Figure 17

Divide By Eleven

Figure 18 shows how the flip-flops FF12-FF13-FF14-FF15 are connected to divide by eleven and the input and output waveform relationships.

When a "1" level signal is applied to the preset inputs, the "Q" output of each flip-flop is forced to the "0" level. Since the two outputs are always at opposite levels, the "$\overline{Q}$" output will be at the "1" level. Gate G6 will produce a positive square wave pulse only when all four input terminals to G6 are at the "0" level, which occurs only on the eleventh pulse (or the tenth state). The square wave pulse at the output of G6 is differentiated by the 470 pF capacitor and the 15 kΩ resistor, which produces a positive pulse on the leading edge and a negative pulse on the trailing edge of the square wave. This negative pulse will cut off Q12 and cause a rise in collector voltage. This rise in voltage is applied to the preset inputs and sets the flip-flops in their preset state again, thus they divide by eleven.



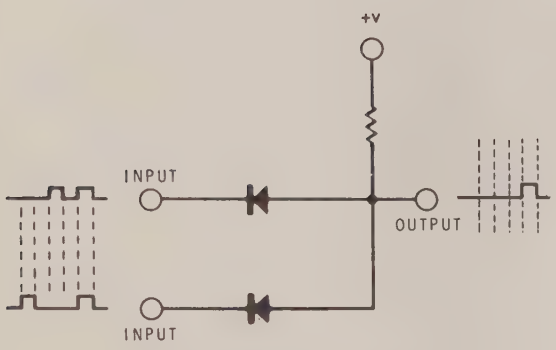
STATE	FF12	FF13	FF14	FF15
0	0	0	0	0
1	1	0	0	0
2	0	1	0	0
3	1	1	0	0
4	0	0	1	0
5	1	0	1	0
6	0	1	1	0
7	1	1	1	0
8	0	0	0	1
9	1	0	0	1
10	0	1	0	1

Figure 18

GATES

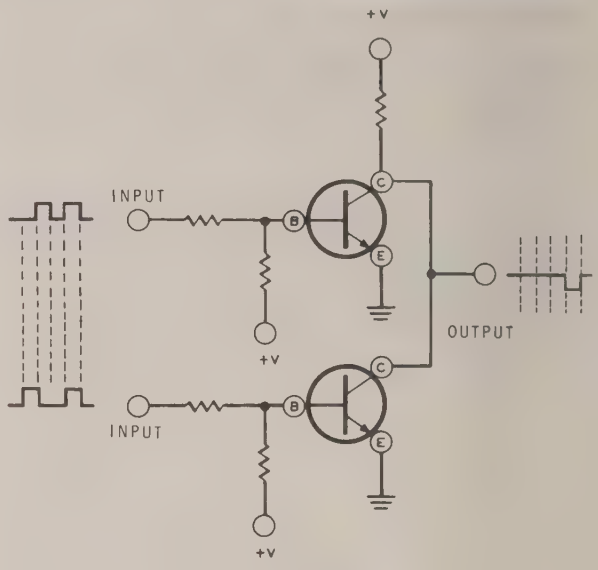
A gate is so named because it allows signals to pass only under controlled conditions. There are four types of gates used in this instrument: AND, NAND, OR, and NOR.

The AND gate requires that all of its input signals be present before it will produce an output. The output signal from an AND gate is the same phase as its input signal. Refer to Figure 19. The NAND gate is an AND gate that inverts its input signal. Refer to Figure 20.



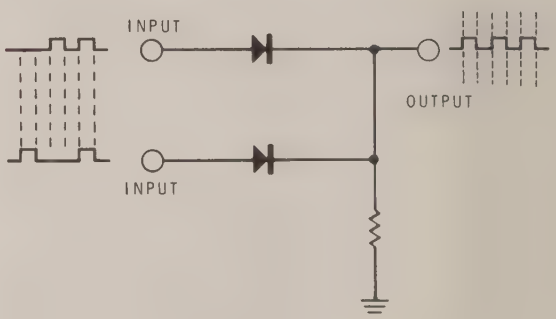
AND GATE

Figure 19



NAND GATE

Figure 20



OR GATE

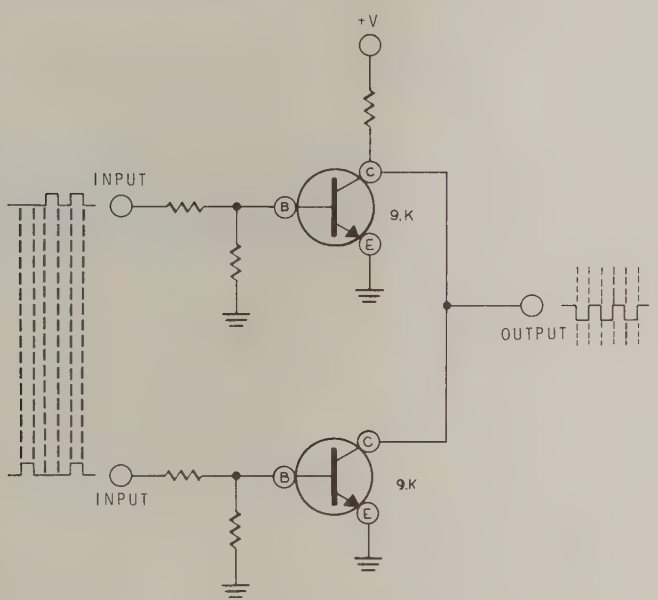
Figure 21

The OR gate produces an output when one or the other of its input signals is present. The output signal from the OR gate is the same phase as its input signal. Refer to Figure 21. The NOR gate is an OR gate that inverts the output signal. In this instrument, resistors and transistors are used in place of diodes in the NOR gate. Refer to Figure 22.

Diodes D1 and D2 function as an OR gate which combines the horizontal and vertical line pulses into the crosshatch pattern. Diodes D3 and D4 function as an AND gate. An output results only when both horizontal and vertical line pulses are present (that is at the cross-over points). This forms the dot pattern.

The "Quad-two-input gate" IC comprises four pairs of transistors. Each transistor pair forms a two-input gate. The output is inverted and the gate may be used for the NAND or NOR function. One such gate is G1, which functions as a NOR gate. In this gate the horizontal and vertical sync pulses are combined to form the composite sync.

Another gate is G5, which functions as a NAND gate. Two input pulses of different repetition rates and pulse duration are combined to give an output only during the brief moment that both inputs are present. Gate G3 uses two pairs of transistors tied in parallel to provide four inputs. Again a narrow output pulse results at the instant all four input pulses are present.



NOR GATE

Figure 22

COMPOSITE SYNC SIGNAL

The outputs of FF3, FF4, and FF5-FF6 are fed into the horizontal sync shaper, NAND gate G2 and Q5. Q5 may be considered as one added input to G2, since the outputs are common. When all inputs to G2 and Q5 are at 0 level, an output signal is produced. This signal remains at the output terminal for the length of time when all the inputs are at the 0 level. Figure 23 shows the time relationship between the input signals at the output of NAND gate G2. The 5.25 μs sync pulse produced is similar to the 5 μs horizontal sync pulse transmitted by the TV station.

Similarly, the outputs of flip-flops FF9, FF10-FF11, and FF15 are fed into the vertical sync shaper, NAND gate G5, to produce the 60 Hz vertical sync pulse which is 252 μs wide. From their respective sync shapers, the signals are fed to NOR gate G1, where the signals are mixed and form the composite (vertical and horizontal) sync signal appearing at the output of G1.

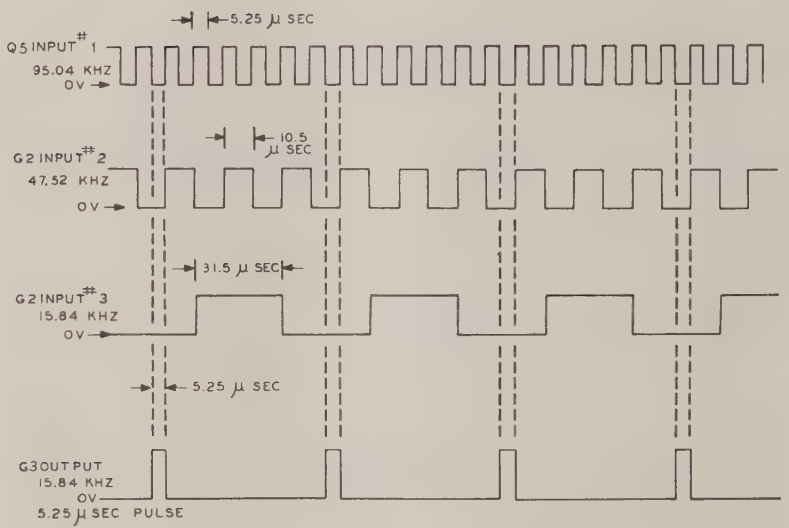


Figure 23

CIRCUIT DESCRIPTION

The Heathkit Color Bar And Dot Generator uses several computer-type logic circuits such as flip-flop multivibrators, AND, NAND, OR, and NOR gates, as well as some common transistor circuits. The Theory Of Operation section of this Manual briefly tells how these circuits operate. This Circuit Description section will explain the operation of these circuits in the Generator. Each of the different circuits will be described separately in the following paragraphs.

Refer to the Schematic Diagram (fold-out from Page 69) and the Block Diagram (fold-out from Page 46) while you read this Circuit Description.

MASTER CLOCK AND WAVE-SHAPING CIRCUITS

A stable 190.08 kHz sine wave is generated by the crystal controlled Pierce oscillator circuit of transistor Q1. This sine wave is then coupled by capacitor C4 to the base of transistor Q2. Q2 is designed as a buffer stage to prevent loading of the master clock oscillator and also to square up the oscillator signal to drive the divider chain. The output from Q1 is large enough to drive transistor Q2 into saturation and cutoff on alternate half cycles, which results in clipping the positive and negative peaks. The square-wave output follows three paths from the collector of transistor Q2.

The first path couples the signal through variable capacitor C5 to the base of transistor Q3. The small value of C5 results in the square wave being differentiated into a series of positive and negative pulses. The positive pulses are amplified by transistor Q3 and are used in developing vertical lines, dots, and crosshatch patterns.

The second path the master clock signal follows is through resistor R8 and capacitor C6 to the trigger input of flip-flop multivibrator FF1 and FF2. Here the pulse for the 3x3 display is formed. R7 is the third path which couples the 190.08 kHz signal to the first flip-flop in the main divider chain.

The signal passes through the divider chain that consists of flip-flops FF3 through FF15. The divider then divides the signal by 2, 3, or 11, to provide all the other signals required to develop the Generator outputs. These flip-flop multivibrators are contained in integrated circuits.

SYNC CIRCUITS

The outputs of flip-flop circuits FF3, FF4, and FF5-FF6, are coupled to the horizontal sync-shaper NAND gate which consists of G2 and Q5. When all of the input signals to this NAND gate are at zero volts, a narrow horizontal sync pulse is produced at its output. Similarly, the outputs of FF13 and FF15 are fed to vertical sync-shaper NAND gate G5, to produce the vertical sync pulse. The width of this pulse is made variable by R35, coupled by C24. R35 controls the off-time of the TV raster during the vertical retrace period.

From their respective sync shapers, the signals are fed to NOR gate G1. The signals are combined to form the composite (vertical and horizontal) sync signal. This sync signal is available separately at the Sync jack on the front panel and is also coupled to the sync/video mixer circuit.

VIDEO OUTPUT

To provide a separate variable video signal output, the output of transistor Q7 is applied through the Signal switch and through capacitor C105 to the base of transistor Q10, which operates as a phase splitter. Equal value resistors R102 and R103 in the emitter and collector of transistor Q10 provide identical video signals with opposite polarity. These signals are then applied to opposite ends of video level control R204. When the wiper of control R204 is in the center of its rotation, the signal at the wiper is at a minimum. Moving the wiper to either end will provide signals of increasing amplitude and opposite polarity.

COMBINED SYNC AND VIDEO SIGNAL

The sync and video signals are combined by transistors Q7, Q8, and Q9. Q9 is cut off only on color blanking. The video signal from lug 10 of the Pattern switch is applied to the base of transistor Q8. The output signal of transistor Q8 is developed across load resistor R26. This resistor is also part of the load resistance for transistor Q7.

When the negative-going sync pulse is applied to the base of the PNP transistor Q7, it is driven into saturation. The collector is clamped to the power supply voltage. This voltage completely overrides the video signal applied to the junction of R25 and R26 from Q8. The resulting signal at the collector of Q7 is a combination of the sync and video signals.

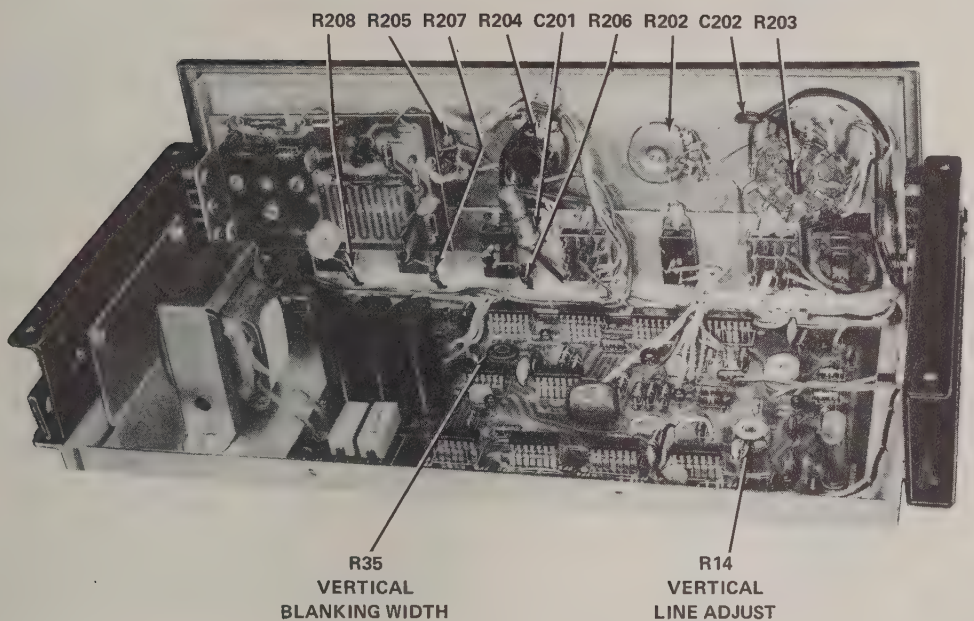
COMBINED RF AND VIDEO SIGNAL

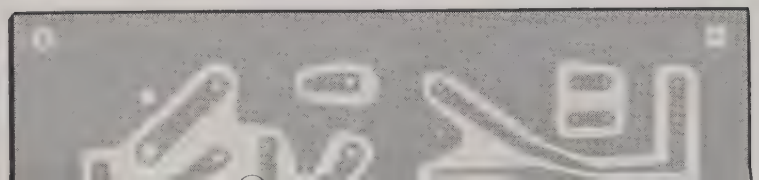
The Hartley oscillator circuit, consisting of Q11, C108, and printed circuit coil L2, generates a signal in a range from 50 to 100 MHz (channels 2 through 6). To provide a combined RF and video signal, the sync/video output of Q7 is mixed with the output of Q11 at the cathode of modulation diode D101. As the forward bias on the diode is increased by the video/sync signal, its effective resistance is decreased. This results in a greater percentage of RF appearing across RF Level control R205. The wiper of R205 picks off a portion of the total available modulated signal.

POWER SUPPLY

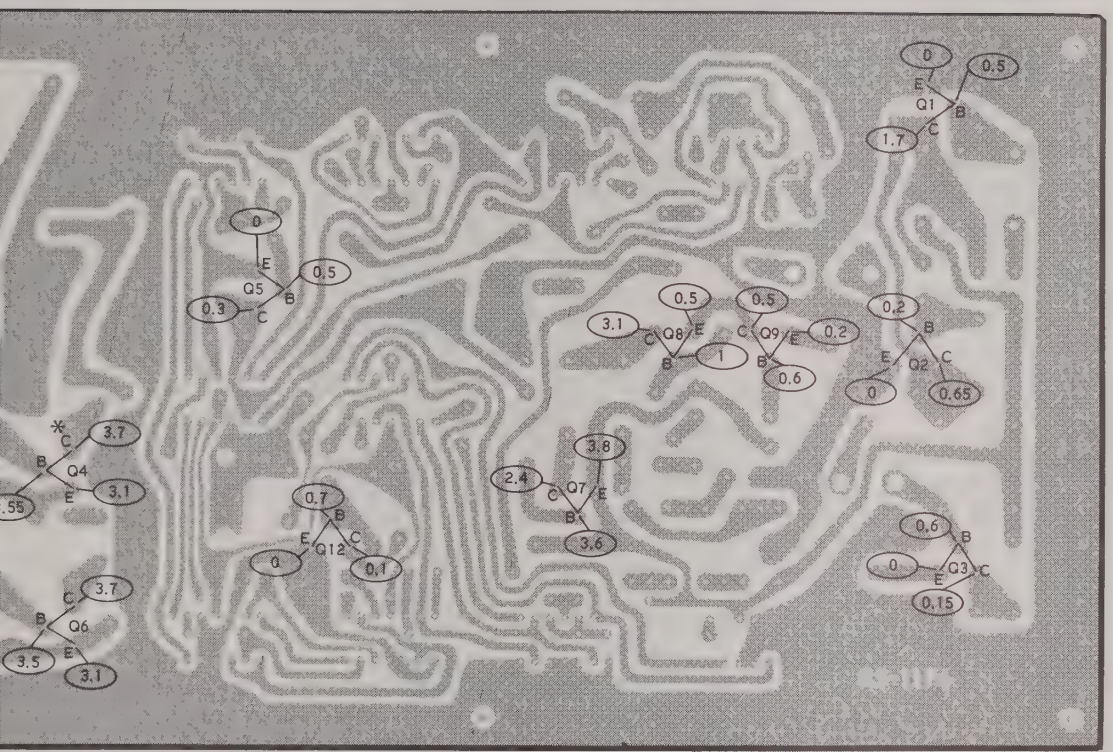
The positive 3.6 volts is provided by the transformer operated full-wave power supply. Resistors R33 and R34 together with capacitors C21, C22, and C23 make up the filtering network. Zener diode ZD1 regulates the output to maintain a constant positive 3.6 volts. This power supply can be wired to operate from a 120 or 240 VAC 50/60 Hz line voltage.

CHASSIS PHOTOGRAPH

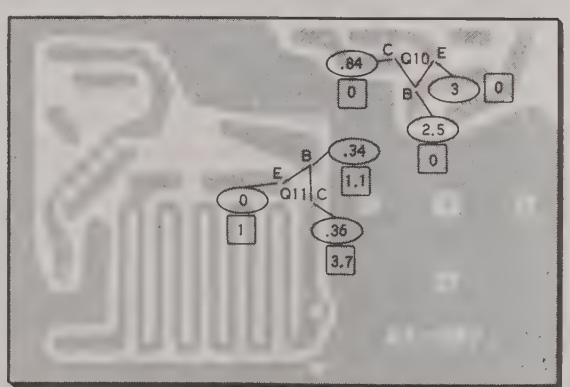




VOLTAGE CHARTS



* 4.5 MHz SWITCH ON

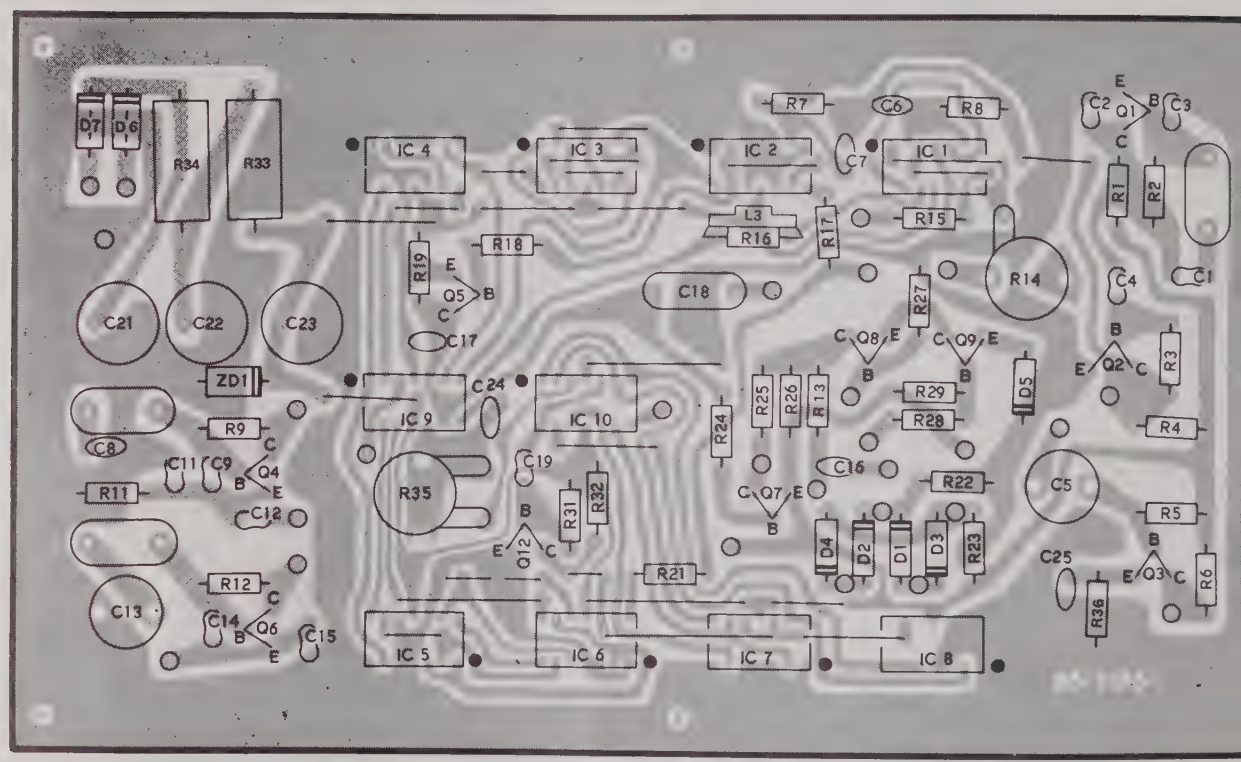


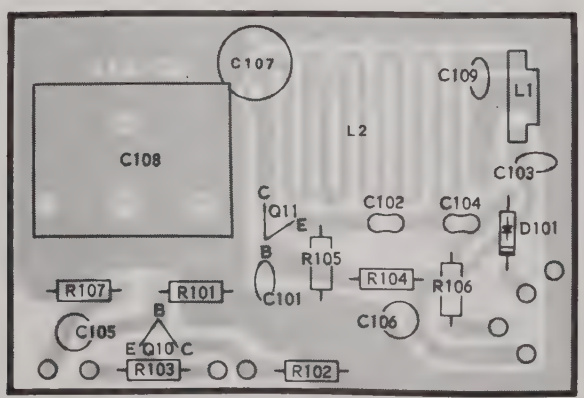
RF VOLTAGES

VIDEO VOLTAGES, SIGNAL SWITCH IN VIDEO POSITION

CIRCUIT BOARD X-RAY VIEWS

(VIEWED FROM FOIL SIDE)





REPLACEMENT PARTS PRICE LIST

To order replacement parts, refer to the "Price Each" column and use the Parts Order Form furnished with this kit. If a Parts Order Form is not available, refer to "Replacement Parts" inside the rear cover of the Manual.

PART No.	PRICE Each	DESCRIPTION
RESISTORS		
1/2 Watt		
1-111	.10	150 Ω
1-4	.10	330 Ω
1-9	.10	1000 Ω
1-90	.10	2000 Ω
1-122	.10	3300 Ω
1-46	.10	3900 Ω
1-43	.10	4700 Ω
1-113	.10	5600 Ω
1-105	.10	10 kΩ
1-109	.10	12 kΩ
1-21	.10	15 kΩ
1-58	.10	22 kΩ
1-124	.10	27 kΩ
1-76	.10	33 kΩ
1-47	.10	56 kΩ
1-26	.10	100 kΩ
1-30	.10	270 kΩ
5 Watt		
3-7-5	.15	11 Ω wire-wound
CAPACITORS		
Resin		
20-52	.35	7.5 pF
20-99	.15	22 pF
20-101	.15	47 pF
20-76	.15	68 pF
20-106	.30	390 pF
20-113	.30	470 pF
20-107	.40	680 pF
20-108	.20	200 pF
Disc		
21-115	.20	9 pF
21-140	.10	.001 μF
21-27	.10	.005 μF
21-95	.15	.1 μF
Other Capacitors		
25-147	.50	10 μF tubular electrolytic
25-115	.40	10 μF vertical electrolytic
25-148	.95	1000 μF electrolytic
26-130	2.00	Variable capacitor
27-28	.20	.1 μF Mylar
31-36	.85	Trimmer capacitor

PART No.	PRICE Each	DESCRIPTION
CONTROLS-SWITCHES		
10-270	.55	200 Ω control
10-269	.50	2000 Ω (2 kΩ) control
10-201	.40	10 kΩ miniature control
10-393	.55	5 MΩ miniature control
19-116	1.00	10 kΩ control with switch
60-24	.50	SPST rocker switch
60-28	.95	3PDT rocker switch
63-472	2.35	Rotary switch
CLIPS-JACKS-SOCKETS		
260-1	.10	Alligator clip
260-52	.15	Lead piercing alligator clip
260-31	.05	Fahnestock clip
436-11	.15	Red banana jack
436-22	.15	Black banana jack
436-24	.15	White banana jack
436-29	.20	Green banana jack
436-30	.20	Blue banana jack
434-148	.30	AC power socket
432-144	.01	IC connector
DIODES-CRYSTALS-PILOT LAMP		
56-20	.25	Crystal diode 1N295 (red-white-green)
56-50	.85	Zener diode
57-27	.50	Silicon diode
404-3	4.45	3563.795 kHz (3.56 MHz) crystal
404-4	3.10	4500.000 kHz (4.5 MHz) crystal
404-343	4.95	190.08 kHz crystal
412-24	1.10	Pilot lamp
TRANSISTORS-INTEGRATED CIRCUITS		
NOTE: A transistor or IC (integrated circuit) may be identified by either the part number or the manufacturer's number or both.		
417-108	.55	2N3692 transistor
417-801	.20	MPSA20 transistor
417-116	.60	S2091 (2N3638) transistor
443-21	1.20	MC717P IC
443-9	2.80	MC790P IC
443-10	1.80	MC723P IC

PART No.	PRICE Each	DESCRIPTION
WIRE-CABLE-SLEEVING		
89-16	.10	2-wire lamp cord
89-23	.75	3-wire line cord
134-192	.65	Small wiring harness
134-193	2.35	Large wiring harness
340-8	.05/ft	Bare wire
343-9	.10/ft	Shielded cable
347-38	.25/ft	4-wire cable
346-4	.05/ft	Small sleeving
340-11	.05/ft	Large bare wire
346-46	.15/ft	1/4" heat shrinkable sleeving
INSULATORS		
73-20	.10	Red alligator clip insulator
73-21	.10	Black alligator clip insulator
75-29	.10	4-wire cable strain relief
75-30	.10	*Round line cord strain relief
75-71	.10	Flat line cord strain relief
75-107	.10	Shielded cable strain relief

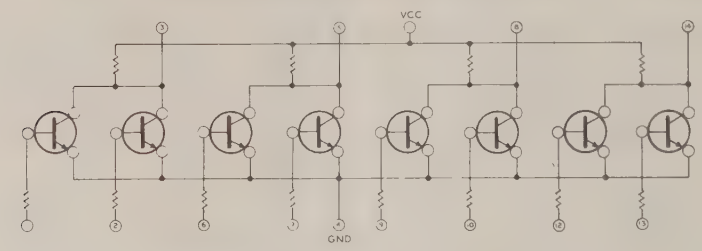
*This strain relief is supplied for areas outside the U.S., where two or three lead round line cords are required.

PART No.	PRICE Each	DESCRIPTION
HARDWARE		
250-156	.05	4-40 x 1/8" setscrew
250-138	.05	6-32 x 3/16" screw
250-56	.05	6-32 x 1/4" screw
250-229	.05	6-32 x 1/4" phillips head screw
250-535	.25	6-32 x 1/4" decorative head screw
250-365	.05	#6 x 1/4" hex head screw
250-250	.05	6-32 x 1/2" black screw
250-304	.15	Threaded stud
252-3	.05	6-32 nut
252-7	.05	Control nut
435-9	.10	Push-on nut
253-10	.05	Control flat washer
254-1	.05	#6 lockwasher
254-4	.05	Control lockwasher
259-1	.05	#6 solder lug

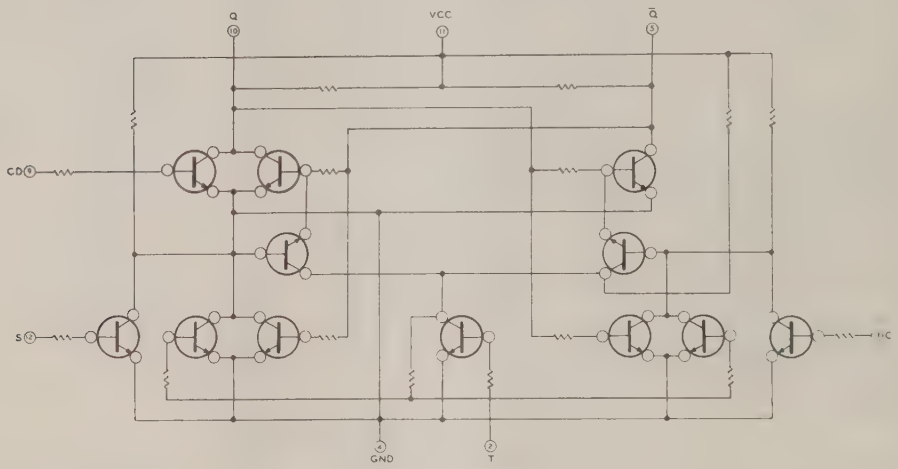
PART No.	PRICE Each	DESCRIPTION
BUSHING-KNOBS-FEET		
455-38	.10	Shaft bushing
455-50	.10	Knob insert
462-246	.25	Large knob
462-248	.60	Small knob
261-28	.05	Foot
261-30	.10	Line cord retainer
METAL PARTS		
90-401-2	2.60	Cabinet shell
100-771	.85	Cabinet side rail
100-841	1.50	Front panel assembly
100-842	1.60	Rear panel assembly
200-553	1.25	Chassis
204-759-1	.15	End cap
204-816	.25	Tuning capacitor mounting bracket
210-35	2.90	Bezel
TOOLS		
490-5	.10	Nut starter
490-23	.10	Allen wrench
490-71	.90	Alignment tool
490-111	.10	IC puller
MISCELLANEOUS		
40-581	.15	620 μH coil (blue-red-brown)
54-249	5.00	Power transformer
85-1176-2	3.60	Divider circuit board
85-297-1	1.05	Video-RF circuit board
100-694	.25	Dial pointer
211-32	.35	Plastic handle
432-27	.40	Power plug adapter
421-33	.30	1/4 ampere slow-blow fuse
422-1	.25	Fuseholder
	2.00	Manual (see front cover for part number)
331-6	.15	Solder

The above prices apply only on purchases from the Heath Company where shipment is to a U.S.A. destination. Add 10% (minimum 25 cents) to the price when ordering from a Heathkit Electronic Center to cover local sales tax, postage and handling. Outside the U.S.A. parts and service are available from your local Heathkit source and will reflect additional transportation, taxes, duties and rates of exchange.

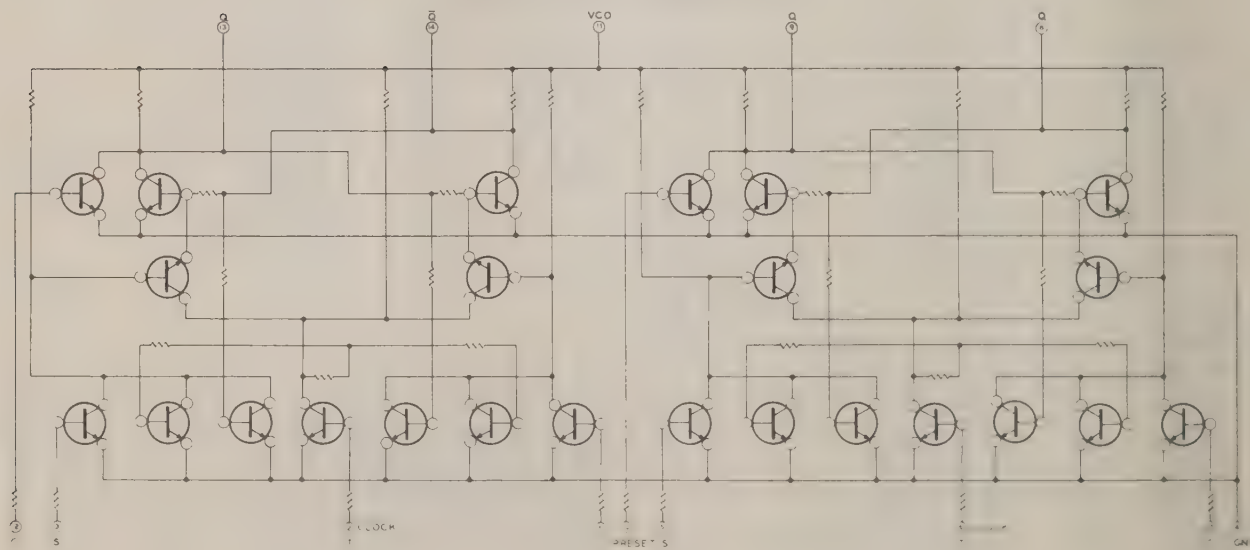
SCHEMATIC DIAGRAM OF THE MC717P INTEGRATED CIRCUIT



SCHEMATIC DIAGRAM OF THE MC723P INTEGRATED CIRCUIT



SCHEMATIC DIAGRAM OF THE MC790P INTEGRATED CIRCUIT



SCHEMATIC OF THE HEATHKIT® COLOR BAR AND DOT GENERATOR

MODEL IG-28

NOTES:

1. RESISTOR AND CAPACITOR NUMBERS ARE IN THE FOLLOWING GROUPS:
   - 1-99 PARTS ON THE DIVIDER CIRCUIT BOARD.
   - 100-199 PARTS ON THE VIDEO-RF CIRCUIT BOARD.
   - 200-299 PARTS ON THE CHASSIS.

2. ALL RESISTORS ARE 1/2 WATT UNLESS MARKED OTHERWISE. RESISTOR VALUES ARE IN OHMS (K=1000, MEG=1,000,000).

3. ALL CAPACITOR VALUES LESS THAN 1 ARE IN µF. VALUES OF 1 AND ABOVE ARE IN pF UNLESS MARKED OTHERWISE.

4. ⬭ THIS SYMBOL INDICATES A POSITIVE DC VOLTAGE MEASUREMENT, TAKEN WITH AN 11 MEGOHM INPUT VOLTMETER, FROM THE POINT INDICATED TO CHASSIS GROUND. VOLTAGES MAY VARY ±20%.

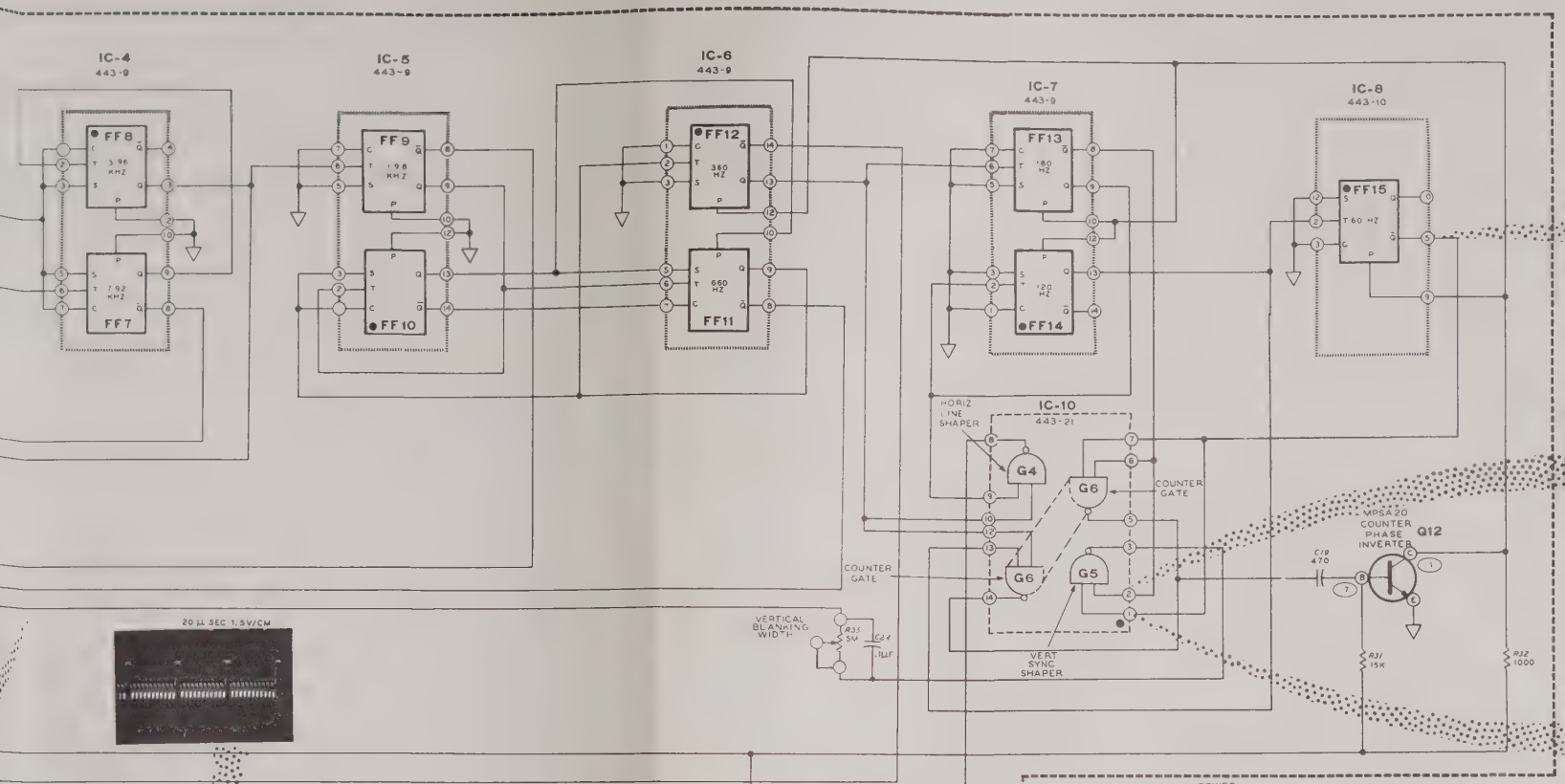
5. SUPPLY VOLTAGES AND GROUND POINTS TO THE INTEGRATED CIRCUITS ARE SHOWN IN A SEPARATE DRAWING ON THE SCHEMATIC.

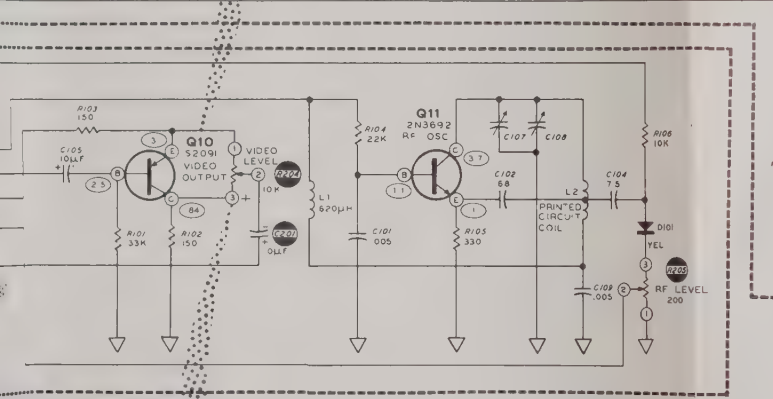
6. VOLTAGE READINGS WERE TAKEN WITH THE PATTERN SWITCH IN COLOR BAR POSITION AND ALL OTHER CONTROLS TURNED FULLY CLOCKWISE EXCEPT AS INDICATED.

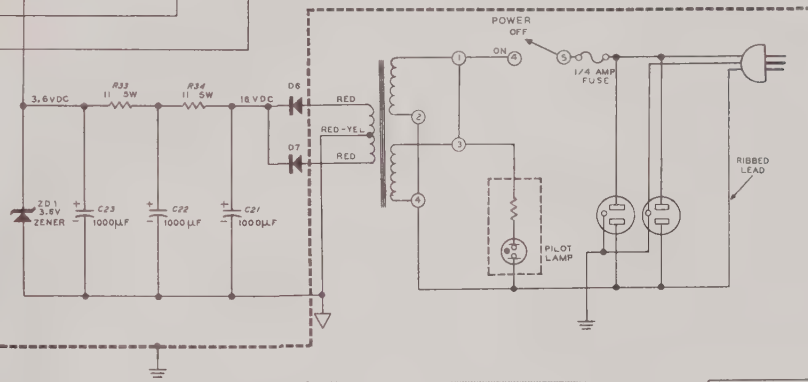
7. REFER TO THE CHASSIS PHOTOGRAPHS AND CIRCUIT BOARD X-RAY VIEWS FOR THE PHYSICAL LOCATION OF PARTS.

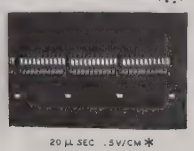
8. ⬬ THIS SYMBOL INDICATES THAT THE PART IS MOUNTED ON THE CHASSIS.

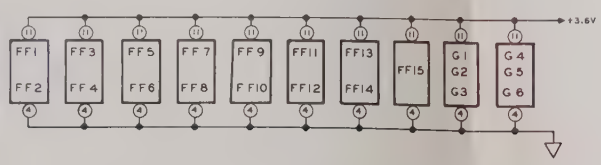
* PATTERN SWITCH MUST BE IN "COLOR BAR" POSITION.

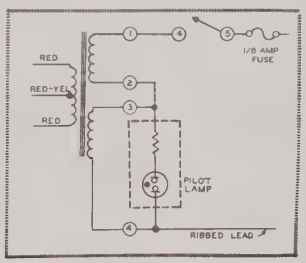




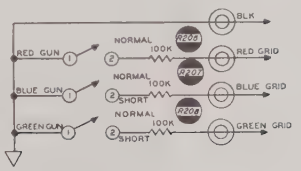


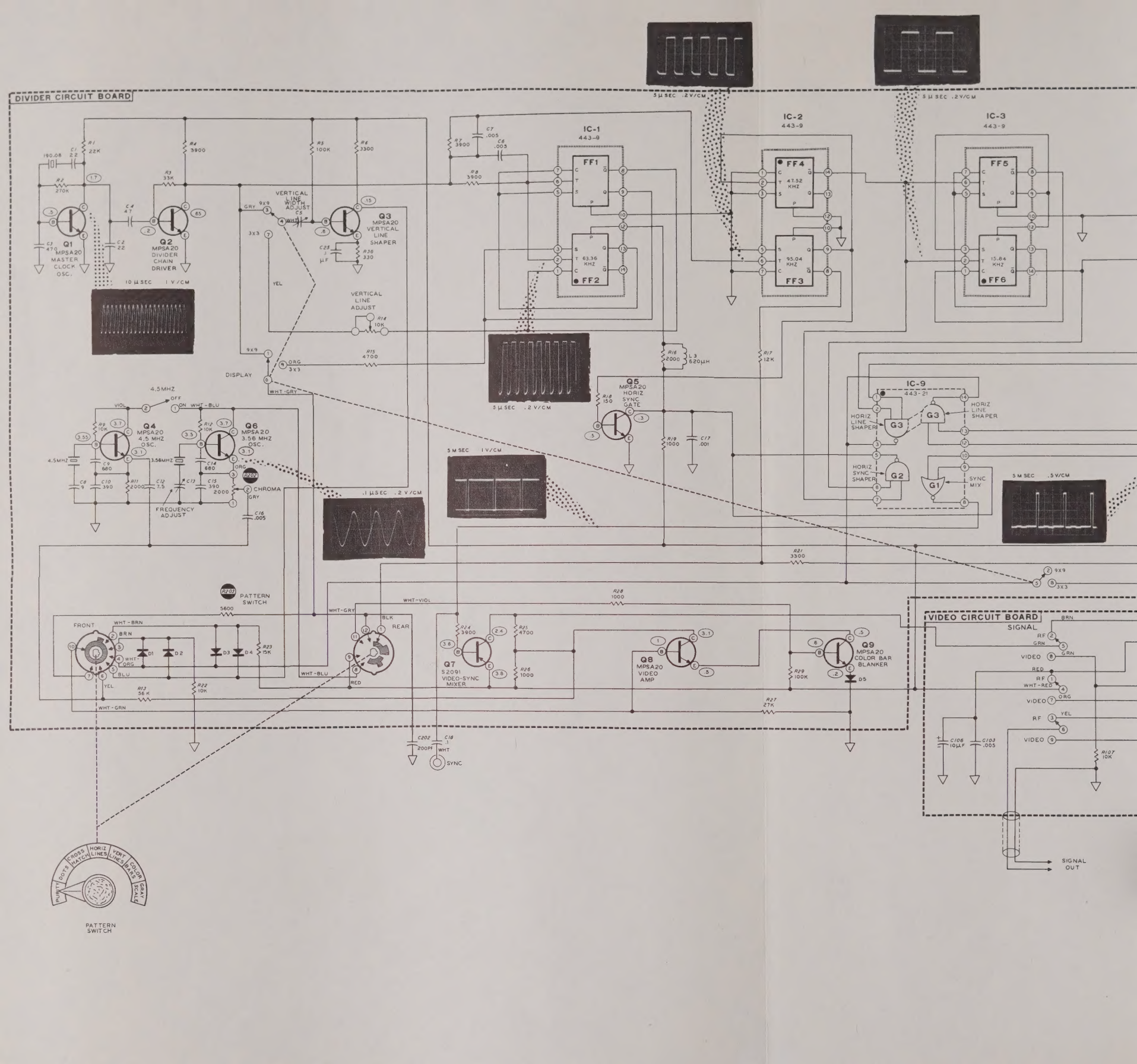






240 VAC WIRING




DIVIDER CIRCUIT BOARD
IC-1
443-9
IC-2
443-9
IC-3
443-9
FF1
FF2
FF3
FF4
FF5
FF6
47.52 KHZ
63.36 KHZ
95.04 KHZ
15.84 KHZ
Q1
MPSA20
MASTER CLOCK OSC.
Q2
MPSA20
DIVIDER CHAIN DRIVER
Q3
MPSA20
VERTICAL LINE SHAPER
VERTICAL LINE WIDTH ADJUST
VERTICAL LINE ADJUST
DISPLAY
Q4
MPSA20
4.5 MHZ OSC.
Q5
MPSA20
HORIZ SYNC GATE
Q6
MPSA20
3.56 MHZ OSC.
FREQUENCY ADJUST
CHROMA
PATTERN SWITCH
Q7
S2091
VIDEO-SYNC MIXER
Q8
MPSA20
VIDEO AMP
Q9
MPSA20
COLOR BAR BLANKER
IC-9
443-21
HORIZ LINE SHAPER
HORIZ SYNC SHAPER
SYNC MIX
G1
G2
G3
FRONT
REAR
SYNC
VIDEO CIRCUIT BOARD
SIGNAL
SIGNAL OUT
PATTERN SWITCH
CROSS HATCH
DOTS
HORIZ LINES
VERT LINES
COLOR BARS
GRAY SCALE
PURITY

CUSTOMER SERVICE

REPLACEMENT PARTS

If you need a replacement part, please fill in the Parts Order Form that is furnished and mail it to the Heath Company. Or, if you write a letter, include the:

- **Part number** and **description** as shown in the **Parts List.**
- Model number and Series number from the blue and white label.
- Date of purchase.
- Nature of the defect.

Please do not return parts to the factory unless they are requested. Parts that are damaged through carelessness or misuse by the kit builder will not be replaced without cost, and will not be considered in warranty.

Parts are also available at the Heathkit Electronic Centers listed in your catalog. Be sure to provide the Heath part number. Bring in the original part when you request a warranty replacement from a Heathkit Electronic Center.

NOTE: Replacement parts are maintained specifically to repair Heathkit products. Parts sales for other reasons will be declined.

TECHNICAL CONSULTATION

Need help with your kit? . . . . Self-Service? . . . . Construction? . . . . Operation? . . . . Call or write for assistance. You'll find our Technical Consultants eager to help with just about any technical problem except "customizing" for unique applications.

The effectiveness of our consultation service depends on the information you furnish. Be sure to tell us:

- The Model number and Series number from the blue and white label.
- The date of purchase.
- An exact description of the difficulty.
- Everything you have done in attempting to correct the problem.

Also include switch positions, connections to other units, operating procedures, voltage readings, and any other information you think might be helpful.

Please do not send parts for testing, unless this is specifically requested by our Consultants.

Hints: Telephone traffic is lightest at midweek. . .please be sure your Manual and notes are on hand when you call.

Heathkit Electronic Center facilities are also available for telephone or "walk-in" personal assistance.

REPAIR SERVICE

Service facilities are available, if they are needed, to repair your completed kit. (Kits that have been modified, soldered with paste flux or acid core solder, cannot be accepted for repair.)

If it is convenient, personally deliver your kit to a Heathkit Electronic Center. For warranty parts replacement, supply a copy of the invoice or sales slip.

If you prefer to ship your kit to the factory, attach a letter containing the following information directly to the unit:

- Your name and address.
- Date of purchase.
- Copies of all correspondence relevant to the service of the kit.
- A brief description of the difficulty.
- Authorization to return your kit C.O.D. for the service and shipping charges. (This will reduce the possibility of delay.)

Check the equipment to see that all screws and parts are secured. (Do not include any wooden cabinets or color television picture tubes, as these are easily damaged in shipment.) Place the equipment in a strong carton with at least THREE INCHES of *resilient* packing material (shredded paper, excelsior, etc.) on all sides. Use additional packing material where there are protrusions (control sticks, large knobs, etc.). If the unit weighs over 15 lbs., place this carton in another one with 3/4" of packing material between the two.

Seal the carton with reinforced gummed tape, tie it with a strong cord, and mark it "Fragile" on at least two sides. Remember, the carrier will not accept liability for shipping damage if the unit is insufficiently packed. Ship by prepaid express, United Parcel Service, or insured Parcel Post to:

Heath Company
Service Department
Benton Harbor, Michigan 49022

HEATH

Schlumberger

MP MASTER

MA23027

HEATH COMPANY • BENTON HARBOR, MICHIGAN

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